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FIGHTING THE CORN BORER
WITH MACHINERY IN THE
TWO-GENERATION AREA

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FIGHTING THE CORN BORER WITH MACHINERY IN THE TWO-GENERATION AREA¹

By C. O. REED, *Professor of Agricultural Engineering, Ohio State University*, and R. B. GRAY, *Senior Agricultural Engineer, Division of Agricultural Engineering, Bureau of Public Roads*, collaborating with L. H. WORTHLEY, *Principal Administrative Officer in Charge European Corn Borer Division, Plant Quarantine and Control Administration*, and D. J. CAFFEY, *Senior Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology*

Control of the European corn borer—the duty of every New England plant raiser and handler—still depends upon (1) actually destroying infested plant material, or (2) treating infested material in a way that kills the incased caterpillars (larvæ), or (3) rendering plant material unfit, in position or condition, to furnish further protection to the insect. Such procedure involves what are known as mechanical methods of control. These in turn depend largely upon the use of tools, implements, and machinery.

What precautions should be taken in pursuing these methods? What implements best fit into the program? What are the latest improvements and best practices? How should machinery be used and adjusted for best results? This bulletin attempts to answer these questions briefly and practically, and to offer other practical hints and suggestions applicable to the areas where the corn borer passes two generations annually. Generally speaking, such areas lie east of the Connecticut River in New England.

Conditions vary widely with size of farm or garden, crops grown, topography, and soils. Farmers and gardeners can not all have the same kinds of implements; they can not all follow the same system and practices. But each farmer, each market gardener, each home gardener, each commercial florist, each canner should examine these pages for valuable suggestions as to how to use more effectively the implements he already has, and to study his own conditions for any possibility of adopting new types of machines or of following better practices that may make it easier and more economical for him to control the common enemy.

HOW TO PROCEED

First, read carefully the material on the next 10 pages. This gives foundation facts and general information in a nontechnical manner. A good working knowledge of a few fundamentals will simplify the whole matter of control and help you make applications more

¹ Most of the information on plows and plowing beginning on page 20 is taken by permission from copyrighted Bulletin 80, *Plows and Good Plowing*, by C. O. Reed and E. A. Silver, published by the Agricultural Extension Service of Ohio State University.

intelligently, more effectively, and perhaps easier for your own conditions.

Then turn back to the subject reference list; find there the class of individual under which your activity falls; and read the special references to your own business.

BRIEF LIST OF COMMON PLANTS ATTACKED BY THE CORN BORER

If you raise or handle any of the plants named in Table 1 you should interest yourself in corn-borer control. For a more complete list, with parts attacked, appearance, and remarks, see United States Department of Agriculture Bulletin 1476, A Progress Report on the Investigations of the European Corn Borer.

TABLE 1.—*Common plants attacked by corn borer in New England*

Field crops	Garden crops	Flowers
Field corn.....	Rhubarb.....	Dahlia.
Silage corn.....	Beets.....	Aster.
Sweet corn.....	Celery.....	Chrysanthemum.
Beans.....	Beans.....	Zinnia.
Beets.....	Spinach.....	Calendula.
Celery.....	Peppers.....	Canna.
Potatoes.....	Tomatoes.....	Salvia.
Rhubarb.....	Potatoes.....	Geranium.
Spinach.....	Swiss chard.....	Hollyhock.
Peppers.....	Eggplant.....	Gladiolus.
Tomatoes.....	Artichoke.....	Goldenglow.
Soybeans.....		
Sweetclover.....		
Cowpeas.....		
Buckwheat.....		

In addition to the foregoing list, coarse-stemmed pithy weeds of many kinds (fig. 1) are a constant source of danger in field, garden, city lot, plot, and fence row. When disturbed in its natural habitat in a desirable host plant, the borer often leaves its host and seeks refuge in near-by weeds. For instance, when celery and beet wastes dry in the field the borers formerly incased therein seek refuge in other vegetation near by.

This menace of weeds must be kept in mind by all growers. A clean-up is not complete unless proper attention is given to coarse-stemmed weeds, in addition to the proper disposal of the actual crop wastes.

WHEN MAN'S EFFORTS COUNT

Thus far the only way man has to control the borer, by practical methods which can be applied generally, is to pursue any of the three methods mentioned in the first paragraph and to use these methods when the insect is in the caterpillar or larval stage. The more caterpillars killed, the fewer there will be to turn into moths; the fewer moths, the fewer eggs to produce the next generation.

The caterpillars always seek refuge, or live, within the stems, stalks, or other parts of plants; hence the proper treatment of all infested material means the destruction of borers.

From about September 15 until May 1 practically all of the insects are in the caterpillar stage; these are known as the overwintering larvae. Any infested plant material which is handled during this

period should be treated by any of the methods mentioned in the first paragraph and described further below. Furthermore, all infested plant material should be so treated prior to May 1, because



FIGURE 1.—Corn-borer injury to various plants. Top at left: Larvae and pupae in cornstalks, and young tassel attacked by the insect. Male and female moths drawn on same scale as the corn. Top center: A female moth with cluster of eggs on a section of corn leaf on a considerably larger scale. Top right: Mature tassel showing typical injuries by caterpillar (the broken tassel stem is often the most noticeable evidence of the presence of the insect during the early summer months). Center: External and internal views of injuries inflicted on two ears of sweet corn. Lower half of the figure: Snap beans, beets, and celery attacked by the borer, cornstalk containing caterpillars, corn stubbles cut away to show how the caterpillars hide themselves in the fall, winter, and early spring months, smartweed, which is a favorite food at times, barnyard grass, which in Massachusetts is often heavily infested, and cocklebur plant, a weed that often serves as a breeding place for the pest. (Walton)

soon after that date the overwintering larvae begin their transformation to the pupal and moth stages. After the moth emerges man is, as yet, helpless to prevent reproduction of the insect.

From about May 10 until September 15 the insect reproduces, the eggs hatch, the young larvae develop rapidly, they pupate, turn to moths, and a second generation gets under way. During this period larvae, pupae, moths, and eggs may all exist at the same time. Hence, man's only recourse then is to promptly and properly treat all dangerous plant material whenever his system permits him to handle it—and to do so at every opportunity.

WHERE THE BORER LIVES

The caterpillars live and feed within or upon cornstalks and cobs (fig. 2); within the coarse, pithy parts of field crops, vegetables (fig. 3), weeds, and flowers (fig. 4), wherever these may be above the surface of the ground. Also the caterpillars may live through the winter in such material, even when it is buried.



FIGURE 2.—General view of a field of sweet corn ruined by European corn borer. No marketable ears were obtained from this field. Medford, Mass.

When disturbed, the borer may leave its former host plant and take refuge in near-by plant material into which it can crawl or bore, such as the curled-up portions of leaves and husks, short pieces or shattered pieces of stalks and stems, weeds, and even exposed root and stubble parts. All such parts of sufficient size and of favorable condition to harbor large or partly developed larvæ are a source of danger.

The caterpillar can crawl at least 25 feet in search of new host material. This emphasizes the importance of cleaning up all dangerous trash in addition to properly handling the actually infested material.

PRECAUTIONS CONCERNING BURYING

Another fundamental thing which every plant grower must keep in mind is the behavior of the borer when buried. When infested

plant material is buried under finely granulated soil, the incased caterpillars tend to crawl to the surface, providing the burying is done when temperature and moisture conditions permit them still to

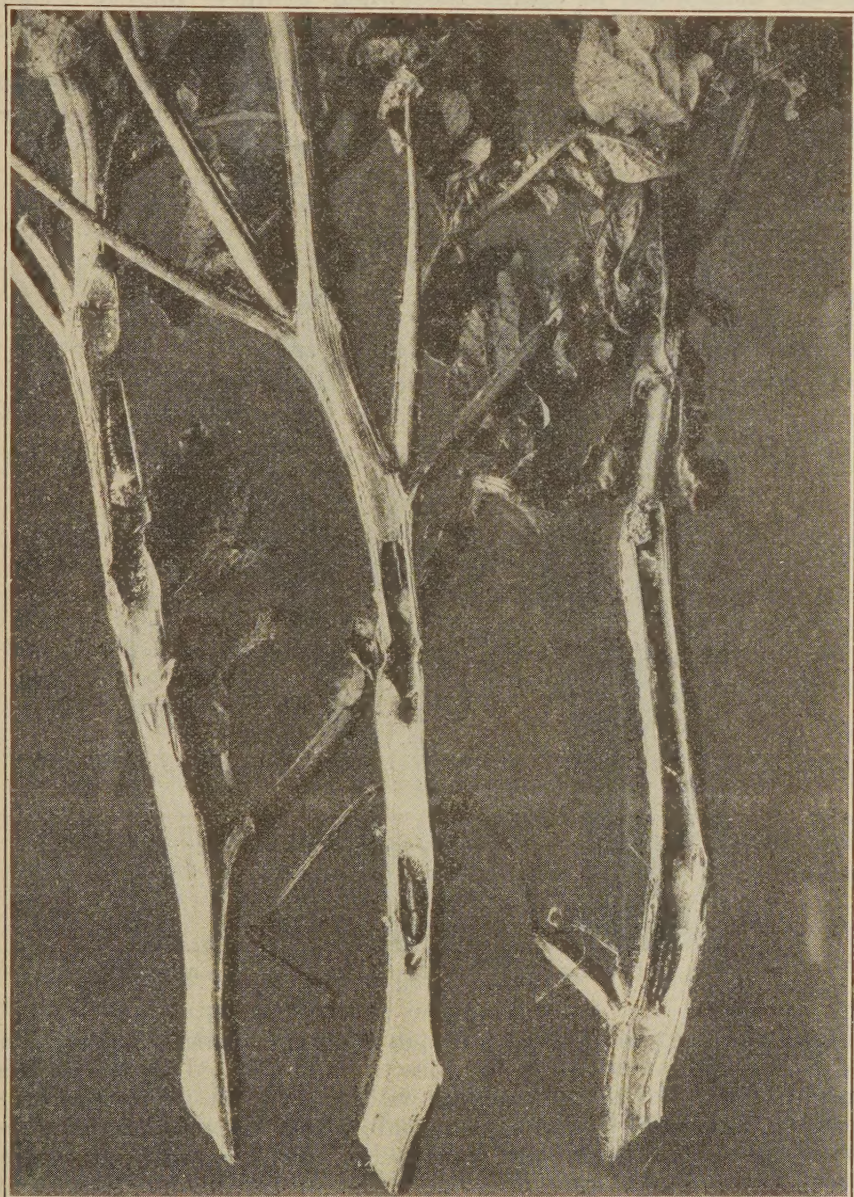


FIGURE 3.—Potato stalks sectioned to show typical work of European corn borer larvae therein and pupae in position. Fifty-four per cent of the plants in this field were infested. Winchester, Mass.

be active. If the caterpillars succeed in getting to the surface, and if they can find there trash into which they can crawl for further protection, they may be safe to continue their life cycle. But, if no trash can be found by the caterpillars when they reach the surface,

they die from exposure or are attacked by natural enemies, such as birds, beetles, and ants.

If borers are buried when they are inactive, many die; the remainder may come to the surface when weather conditions again permit activity. The deeper the borers are buried, the less their chance of survival.

It should be clearer now why certain recommendations are made, and how the habits of the insect—not the opinions of control officials—dictate what shall be good control practice.



FIGURE 4.—Gladiolus stems showing European corn-borer infestation

Garden refuse which must exist in the fall should be cleaned up late in the fall, after all of the insects have reached the caterpillar stage and have secluded themselves within the trash. Or such refuse should be disposed of in the spring before the insect begins its transformation to the pupal stage. This does not mean that all garden refuse should be left until fall or spring; as much of it as possible should be properly disposed of through the summer when the young larvae are establishing themselves.

If garden refuse is buried instead of burned, it should be buried deep—at least 6 inches, and deeper, if possible—then covered with finely granulated soil, which should be tamped. Also the surface of the ground should be left clean.

If plowing is used as a control measure in the fall, trash should be turned under to a depth of at least 6 inches, and the plowing should

be done as late as possible. Six-inch plowing after November 1, properly done, is one of the most effective control measures in New England; a high percentage of the borers thus plowed under die. When plowed under in the spring, about 90 per cent of the caterpillars come to the surface.

If the plowing is shallower than 6 inches, if it must be done prior to November 1, or if it must be done in the spring, then it must be clean—that is, no trash or vegetable debris should be left on the surface to harbor the borers that succeed in coming up.

An illustration will serve to emphasize the need for intelligent application of plowing. It is common practice to plow sweet-corn fields early in August. Such plowing, although it may be 6 inches in depth, is too early to secure the benefits of the kill produced by late fall plowing. Hence the crop remnants left after the harvest of sweet-corn ears should be properly treated before the field is plowed, or the plowing must be absolutely clean and not followed too soon by a subsequent seeding that will furnish host or shelter material for the insect.

DESTROYING INFESTED PLANT MATERIAL OR MATERIAL WHICH MAY FURNISH A REFUGE

The common and most effective way in which plant wastes are actually destroyed is by burning. The material must either be consumed by fire or subjected to sufficient heat to kill the incased larvae. This method can be used extensively by home-garden owners and, to some extent, by farmers, market gardeners, produce men, commercial florists, and canners. These latter groups may be especially interested in incinerators described later.

TREATING INFESTED MATERIAL IN A WAY THAT KILLS INCASED CATERPILLARS

Under this heading fall such methods of treating infested material as ensiling corn, using husker-shredders, cutting up or grinding fodder for feed, and stubble pulverizing.

When the corn plant is ensiled the larvæ are killed by the mechanical action of the silo filler or by fermentation in the silo. When corn is put through a husker-shredder or through a field silage harvester a large percentage of the incased caterpillars are killed or mortally maimed, providing the machine is properly equipped, set, and fed.

Putting fodder through a properly equipped cutting box or through a feed mealer is almost sure death to borers, but great care must be taken to clean up around the machine after the cutting process is completed.

RENDERING PLANT MATERIAL UNFIT FOR FURTHER HABITATION

Plowing under cleanly or burying trash properly renders plant material unfit for further habitation by the corn borer. Plow as nearly as practicable at the time when plowing means most in control; plow at least 6 inches deep, if possible; and plow cleanly with all trash buried deep. No trash should appear on the surface after

the field is plowed, and none should reappear on surface after the field has weathered or after it has been harrowed, seeded, or cultivated.

MANURE PILES AND COMPOST HEAPS AND BEDS

Infested material in manure piles and for compost purposes calls for further precautions. If such material heats badly or if the material stands thoroughly soaked with water or juices, some of the incased borers may be killed, but the tendency of the insect is to crawl to more favorable quarters on the surface layers if such are left available. Hence in such cases further treatment of the surface layers may be necessary. Take off the layer of fairly dry stuff down to the point where the material is wet or down to where excessive heating took place. Burn this surface layer material or haul it out to be plowed under or spaded in, then be sure to plow it under cleanly or spade it in cleanly early in the spring.

The surface layers of manure piles and compost heaps, however, are not the only source of danger. The insect may have left the original material and found refuge in near-by weeds or other vegetation. Hence, clean up other dangerous trash immediately adjacent.

TRASH PILES

Burn trash piles thoroughly late in fall or early in the spring, providing the material must be left until fall.

GARBAGE

Garbage containing refuse from borer-laden plant parts is a menace. The borer will not remain long in garbage if it can find more favorable quarters. When garbage is thrown out on garden plots or hauled out on fields, the caterpillars contained therein may take refuge in other vegetation or trash. This is a source of spread of the insect and a source of reinfestation.

Persons who dispose of their own garbage should burn it or bury it deeply. Hotel keepers, restaurant owners, and housekeepers who enjoy city disposal should insist that such disposal be safe from the standpoint of corn-borer control.

Garbage spread on fields or thrown on garden spots should be plowed under or spaded in deeply and cleanly.

REFUSE PILES ABOUT CANNING AND BROOMCORN FACTORIES, MARKETS, AND PRODUCE-HANDLING ESTABLISHMENTS

Piles of corncobs and husks about canning factories, piles of butts about broomcorn factories, and piles of leaves and trimmings in places where market produce is handled are sources of danger. If such material withers and dries up, the incased borers tend to leave in search of more favorable refuge, and surrounding vegetation probably becomes the host. If the material is sold to farmers for feed or fertilizer, it may be a source of spread and reinfestation. None of this material should be hauled outside of the infested area. If it ultimately reaches the field and is fed there, or if it is spread preparatory to plowing, the farmer should be warned that it is infested waste and is to be handled as such. That means it should be raked up and burned or plowed under cleanly.

HAND PICKING

If conditions or the equipment at hand are such that a perfect job of trash covering can not be done when a garden plot is spaded or a farm field is plowed, the operator still has two chances to turn a poor job into a good one. He may choose to rake and burn heavy trash before he spades or plows. Or, after working the soil, he can pick up by hand the stray bits of trash here and there which have escaped the covering process.

Hand picking is hard, tedious work. Effort is being made by control authorities to devise ways and means of avoiding it. But for the time being it may be much cheaper to do some hand picking than to have to invest in new equipment.



FIGURE 5.—Typical weed area in New England, severely infested by European corn borer

COMMUNITY COOPERATION IN CORN-BORER CONTROL

Inasmuch as control of the corn borer is a community, State, and national problem, it offers excellent opportunity for influence and cooperation—for the good of all—between individuals, neighbors, city and town administrations, business and marketing interests, towns, counties, and States. The individual who becomes a slacker should be reported, and pressure should be brought to bear upon him to join the clean-up movement for his own sake as well as for the welfare of the community in which he lives. Community effort is essential.

Not only should farm fields, barnyards, garden plots, market places, and the premises about canning factories be cleaned up but also the public should see to it that dangerous vegetation on vacant lots is disposed of. Nearly 100 borers per square rod have been found

in such idle or waste places as that shown in Figure 5. When the moths emerge from such spots they can fly as far as 20 miles to deposit eggs on growing vegetation—this may be in your back yard or in your field.

With the corn-borer menace becoming more grave, New England might well afford town, city, county—even State—clean-up periods. A period of three days each fall and each spring might be advertised as “corn-borer clean-up days” and powerful public sentiment aroused to “get the borer.” Backed by bankers, business houses, manufacturers, schools, local clubs, county agents, and by town and State officers, such periods should be a decided success if properly “sold” to the public. At least they would have vast merit in an educational way. They might give the populace of New England the upper hand over a common and very threatening enemy.

Another cooperative, educational move which New England should foster among its farmers is that of plowing matches and plowing demonstrations. These will revive the art of good plowing so necessary in corn-borer control.

MACHINES AND IMPLEMENTS FOR CORN-BORER CONTROL

The balance of this circular is devoted to types, uses, and adjustments of machinery, together with suggestions and precautions. Addresses of manufacturers making various tools can be secured

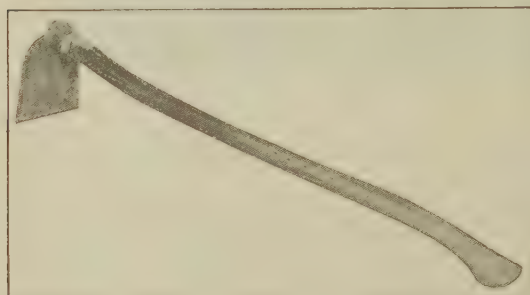


FIGURE 7.—Dutch hoe equipped with ax helve

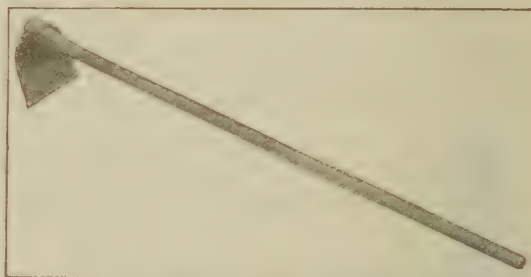


FIGURE 6.—A Common Dutch hoe. Dutch hoes are preferred by many when corn must be cut at the ground surface by hand

upon application to the Boston office of corn-borer control or to the Division of Agricultural Engineering, Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.

HAND CORN CUTTERS

If corn is hand cut and the stubble is not to be or can not be plowed sat-

isfactorily, the stalks should be cut at the ground surface; slightly under the surface is preferable. For this purpose the corn knives shown in Figures 6, 7, 8, and 9 are more effective than regular corn knives. Dutch hoe blades with regular handles are regular merchandise in many hardware stores. Ax helves are often shaved down to fit the Dutch hoe blade and are used in place of the regular handle. The ax handle is especially advantageous, as it furnishes a better grip to prevent the blade from twisting. The

new special blade developed by agricultural engineers (fig. 8) is not yet on the market, but it can be made by any local blacksmith if he will follow the directions and layout given in United States Department of Agriculture Miscellaneous Publication 56.

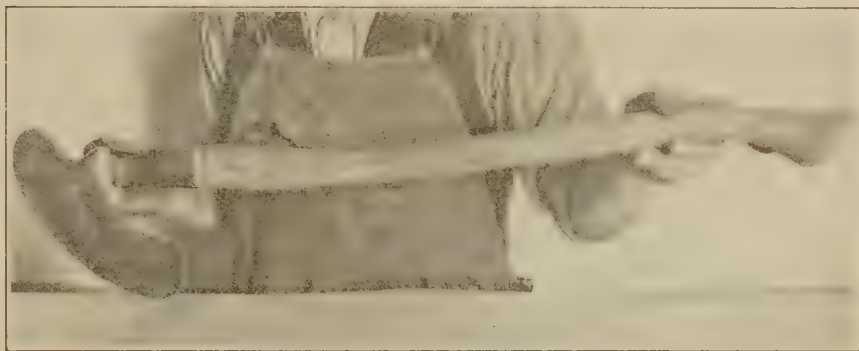


FIGURE 8.—Low-cutting hand knife for harvesting corn

CORN BINDERS

Low-cutting attachments for corn binders can be made very easily. These cut the stalks very close to the ground surface; hence they are a great aid in eliminating the dangers from high stubble.



FIGURE 9.—The new, low-cutting hand knife in position for cutting

United States Department of Agriculture Miscellaneous Publication 56, Low-cutting Devices for Harvesting Corn, shows how low-cutting attachments can be made for a number of corn binders now on farms. It is probable that most manufacturers of corn binders

will, in the near future, have low-cutting attachments available for all of their machines built since 1920.

STALK SHAVERS

Figure 10 shows a homemade stalk shaver for slicing stalks off at the ground surface preparatory to raking and burning. Directions on how to make a stalk shaver for a few dollars are given in



FIGURE 10.—A homemade stalk shaver for cutting stalks off at the ground surface preparatory to raking and burning

United States Department of Agriculture Miscellaneous Publication 69, Construction of a Sled-Type Cornstalk Shaver. Shaving off stalks with a stalk shaver is more satisfactory than poling them off as described under "Breaking over and rolling," page 18.

MOWERS

Mowing field-corn stalks preparatory to raking and burning, or

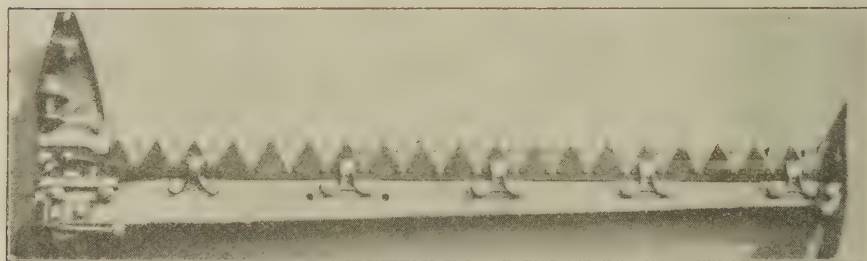


FIGURE 11.—Mower cutter bars equipped with stub guards, known as weed bars, are more successful than standard bars for mowing stalks

mowing sweet-corn stalks preparatory to plowing, is sometimes resorted to. The regular cutter bar of the mower becomes troublesome in that the guards pierce stalks and clogging quickly results. Weed bars carrying stub guards, such as shown in Figure 11, are much more successful; these can be secured from mower manufacturers. If stalks are mowed preparatory to plowing, the mowing should be done in the direction to be followed by the plow.

RAKES

The common steel-toothed sulky dump rake can be used to rake trash into windrows preparatory to burning, providing that the surface is smooth, that the trash is fairly dry and clings together without shattering, and that the operator does not attempt to gather too heavy a load before dumping. The special, close-toothed sulky dump rakes (fig. 12), now marketed by some manufacturers, do good work on smooth ground, often much better than rakes with the ordinary spacing of teeth. In raking cornstalks, however, the sulky dump often fails to rake cleanly enough to finish a field without plowing unless the field is cross raked.

Much better success has been enjoyed with side-delivery rakes. The most satisfactory side rake yet obtained is one with four instead of three tooth bars and carrying extra heavy teeth (fig. 13), the speed of the cylinder remaining normal. This rake on fairly smooth ground has done a perfect job of raking even in heavy stalk growths.

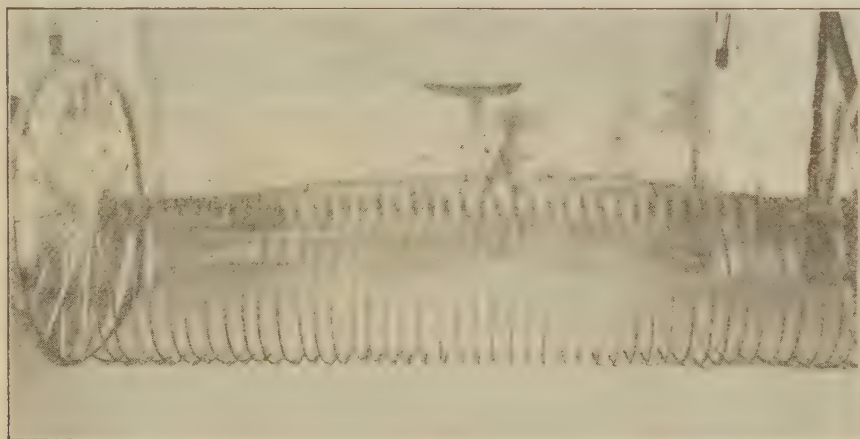


FIGURE 12.—Close-toothed rakes, such as shown here, usually rake infested material more cleanly than rakes with standard spacing

Although this rake has not yet been produced by manufacturers, development work has progressed to the point where manufacturers will probably be willing to place the device on the market soon.

Thus far, hilling corn has proved a handicap in raking stalks cleanly. It is evident that the practice of level cultivation must be resorted to more freely if raking stalks is to be effective in control procedure.

STUBBLE PULVERIZER

The stubble pulverizer, shown in Figure 14, is a special corn-borer tool for shattering the remaining corn stubble when stalks are not cut at the ground surface. The machine can be used only with tractors, as the power to revolve the two beater heads at great speed is taken from the tractor through a power take-off. On level ground which is not soft and where beating conditions are good, a fair job of stubble pulverizing can be done with a 10-20 horsepower tractor. But if the field is rolling, or if the beater blades must be set down to

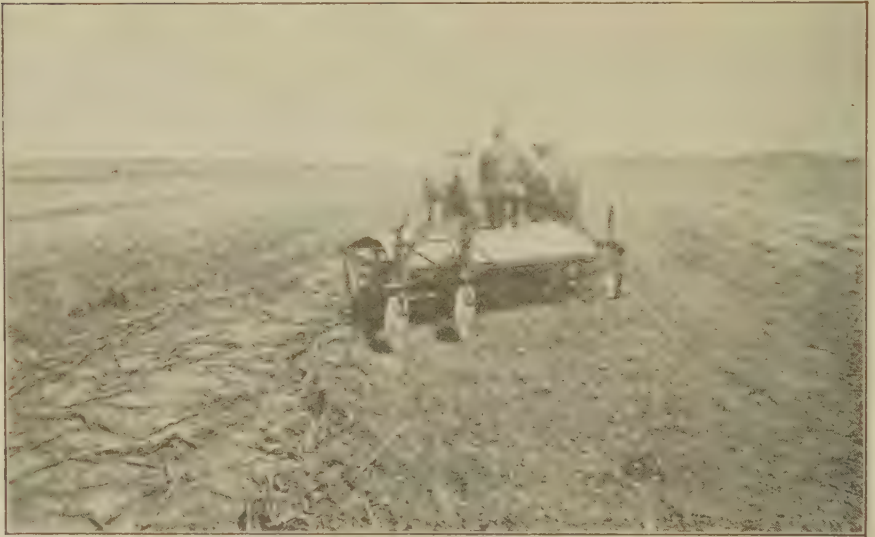


FIGURE 13.—A 4-bar side delivery rake is a great help in cleaning up. This machine is a standard 3-bar rake converted to a 4-bar rake with extra, heavy teeth and special spring devices

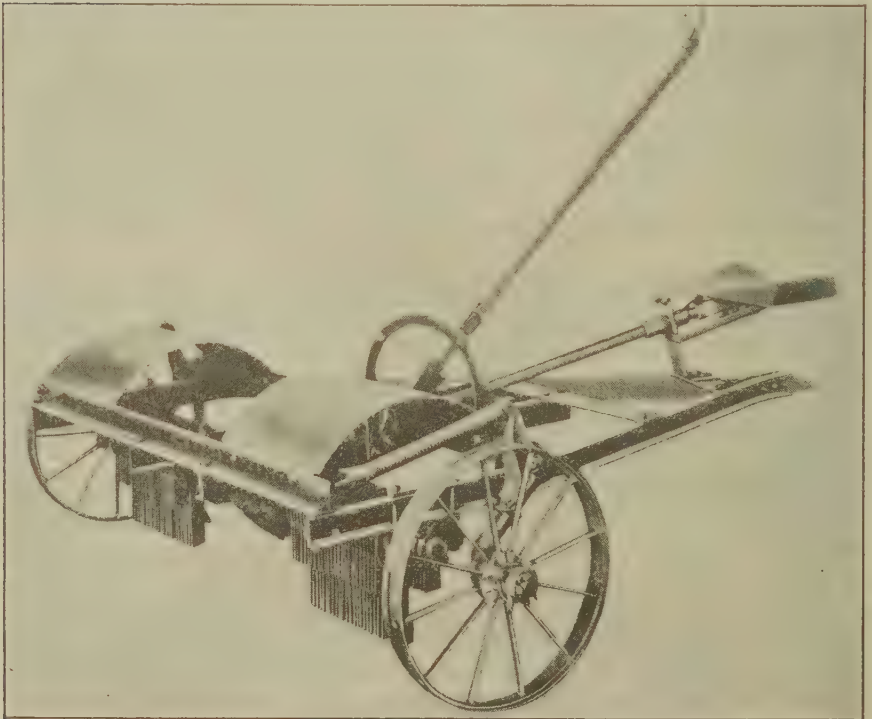


FIGURE 14.—A stubble pulverizer used to shatter corn stubble

work slightly in the soil, a tractor of not less than from 25 to 30 belt horsepower should be used.

The stubble pulverizer is sometimes used on whole stalks and vines to partly reduce such trash to facilitate clean plowing. Under such conditions the machine is not successful in actually killing all borers or in rendering the trash unfit for future habitation. As soon as a cornstalk is torn free from its roots the beater blades may throw this stalk without materially reducing it further. In corn stubble, however, the roots tend to hold the stubble upright as the blades come onto it to shred it into fine bits.

The pulverizer can not be depended upon to do a good job of killing in stubble higher than 10 inches. The machine can be used in gravelly or sandy soils, or in fields where small stones abound; but under these conditions the repair cost is greater than on silts and clays which are not stony.

As the machine is now built, each beater head is $15\frac{1}{4}$ inches wide, and the two heads are 41 inches apart from center to center. For special cases the heads could be set a little closer together by a little machine work. The pulverizer can be used in stubble which has been seeded to grasses. If the lugs are removed from the tractor, if the beater blades are not set too low, and if the ground conditions are good, little harm may occur to the surface.

SILAGE CUTTERS

Inasmuch as the borers are killed by the heat of fermentation in the silo, as well as by the actual process of cutting up the stalks, little need be said regarding silage cutters. Keeping knives sharp and properly adjusted to the shearing bar will undoubtedly kill more borers as well as reduce power requirements. Properly ensiling corn and other borer-laden green material is to be advocated from the standpoint of corn-borer control. Great care must be taken to clean up and properly destroy all uncut trash and loose borers which are found around the cutter, silo, and wagons after the filling operation is completed.

Obviously, corn cut for silage should be cut off at the ground surface.

FIELD SILAGE HARVESTERS

Regular field silage harvesters not only cut the stalks off but also cut them into silage lengths in the field. The cut material is then carried in wagon boxes and is blown into the silo. These machines may have little adaptability in New England for silage corn; yet they may have very decided possibilities for the sweet-corn grower whose acreage is sufficient to justify the investment. They can be used to destroy stalks immediately after the corn is picked. For such conditions the harvesters (fig. 15) are equipped with low-cutting devices and the cutter heads arranged to cut the stalks into from $\frac{1}{4}$ to $\frac{1}{2}$ inch lengths. The cut material is dropped back on the ground, or it can be loaded automatically into wagons if desired.

CUTTING BOXES

Cutting boxes include hand or belt-driven feed cutters used to cut roughage into short lengths preparatory to feeding. If the

material to be cut up is infested with live borers, and if the refuse left after feeding is not to be cared for properly from the standpoint of corn-borer control, then it becomes highly essential that the cutting box be of such type and so set and used that the borers are killed when the host material is put through the cutting box.

If the action of the cutting box does not actually shatter, tear into fine pieces, or shred the sections of cornstalks resulting from the cutting process, then the material should be cut into lengths of not more than from one-fourth to one-half inch. The length of cut on hand-cranked and on belt-driven machines usually depends upon the number of knife blades on the cutter head and upon the timing relation between the cutter head and feed rollers.

If it is impossible to secure the ideal length of cut mentioned, the feeder still has opportunity to handle properly the refuse left after



FIGURE 15.—A field silage harvester, equipped with low-cutting attachment, being used primarily as a corn-borer weapon

feeding. But the closer the machine is set to the safe length of cut, the less the trouble in handling the material left by the animals.

Sharp knives, knives properly adjusted in respect to the shear bar, high pressure on the feeding rollers, even feeding, and short lengths of cut are to be practiced in making the cutting box a more effective corn-borer weapon. Be sure to clean up properly around the machine. Uncut trash and loose borers lying on the floor around the machine are dangerous.

FEED GRINDERS AND FODDER MILLS OR MEALERS

Machines which grind roughage into a mealy consistency are popular with many feeders who want roughage in the most edible form and who want to control the contents of the feed by using a certain combination of hay, cornstalks, or other roughage, and grain in-

redients. These machines are ideal corn-borer weapons when the roughage is ground fine enough to destroy the borers. They are to be widely advocated, from the standpoint of corn-borer control, where their use is economical. Some farmers who have tractors may be interested in owning these mealers cooperatively with their neighbors.

Be sure to clean up properly around the machine after the grinding operation is completed. Untreated trash lying around the machine or strewn between the mow and the grinder is dangerous.

HUSKER-SHREDDERS

The husker-shredder is a rather large machine used to husk out the corn and shred the stalks in one operation. The stalks are usually hauled to the machine directly from the shock, the husked ears are delivered to the bin or wagon, and the shredded stover is blown by the machine into the mow.

Very few of these machines are used in New England. The area of corn and labor available on the average farm generally do not warrant individual ownership and use of these machines in the East. However, there may be opportunity for cooperative ownership or for an owner to do custom work within a community.

These machines are effective corn-borer weapons. The percentage of kill by them depends upon keeping the snapping rolls very tight, upon maintaining the proper speed, and upon even feeding. These factors have more influence than the type of head used, whether it be a shredder head, a cutter head, or a combination.

Inasmuch as many live borers drop from this machine directly to the ground or come through with the shelled corn, not only is it necessary to clean up carefully around the machine but also it is very essential that the trash be disposed of properly. Feed the shelled corn to chickens. Also let the chickens have other droppings from the machine which are of fine consistency. Burn all of the rest of the trash around the machine after the shredding operation is completed; do not put such trash in the mow.

PORTABLE INCINERATORS

Figure 16 shows one type of portable incinerator. It is simply a fire box, grate, and oil-pressure chamber on wheels, in which a good fire is started and refuse kept burning by a slight influx of oil under pressure. These devices have been used with considerable success by control authorities where it was necessary to pick up and burn immediately borer-laden refuse on fields, such as pieces of corn stubble and pieces of stalks which remained exposed on surfaces of fields already sown to small grain. These burners can be forced to burn damp material very readily.

Such devices may have little appeal to farmers; but greenhouse men, commercial florists, produce handlers, canners, and home gardeners should consider them carefully as a practical means of effectively handling borer-laden refuse when effective composting systems are not used. They can be used by farmers to burn damp material which is picked up by hand in fields which can not be plowed cleanly.

BREAKING OVER AND ROLLING

The disk harrow, spike-tooth harrow, flat roller, corrugated roller, and the planker are all practically useless in corn-borer control in so far as their direct killing effect is concerned. The disk harrow does not cut trash into bits which are small enough; rollers, even when weighted heavily, can not crush stalks and borer-laden refuse sufficiently against the ground surface. Each of these devices, however, can be used to break down standing crop refuse as a preliminary step toward better plowing.

If stalks are to be broken off preparatory to raking and burning, and if the breaking can be done when the stalks are frozen and when practically no snow is on the field, a railroad rail or breaking pole affords a cheap and easy means. If the rail is a short piece, one horse is hitched to each end of the rail, or if a full-length rail is used, a team can be placed at each end, and the rail is dragged



FIGURE 16.—One type of portable incinerator

across the field in such a way that the sharp edge along the bottom of the rail strikes the stalks very close to the ground. A breaking pole or boom is often used instead of a rail; this is a straight piece of timber from 12 to 20 feet long, hewn so that the front edge along the bottom is square cornered.

If breaking down stalks or other heavy borer-laden trash is done just prior to plowing simply to facilitate cleaner plowing, then endeavor should be made to bend the stalks down without breaking them off at the ground surface or off from the roots. Stalks and trash nearly always plow under better if the trash is held by the roots. Breaking over can be accomplished by any of the implements mentioned at the beginning of this section. Care should be taken to break stalks down so that they will lean in the direction in which the plowing will be done.

Disking cornstalks previous to plowing is questionable practice from the standpoint of clean plowing. Stalks and other heavy trash usually can be turned under best if the material is fast. When loose and cut into lengths of from 6 to 15 inches, trash is apt to

pitch badly when the furrow slice is turned. Trash which pitches is almost sure to appear exposed either on top of or between the furrow slices.

PLOWS AND PLOWING

The plow is probably the New England farmers' most common and most practical corn-borer weapon. As stated previously, plowing the borer under does not kill it necessarily. If the caterpillar is large enough, and if the weather conditions are right and the season is timely, the caterpillars which are plowed under in trash may crawl to the surface almost immediately. When they reach the surface they may crawl 25 feet in search of plant refuse into which they can bore for further protection. If they can not find such trash, they perish from exposure or are picked up by predators. Hence, the success of plowing as a control measure depends largely upon the plowing being clean with no vegetable matter remaining on the surface of the plowed field. Furthermore, the trash should be buried deeply enough so that none will be brought to the surface by the subsequent tillage operations at a time when the reappearance of trash on the surface would be dangerous. If the soil comes up in clods and trash is exposed to view between the clods, some subsequent tillage operation should be performed soon to further granulate the soil and to fill the fissures between the clods.

Plowing is a form of mechanical control to which New England farmers can and should pay more attention. By more attention to plows and more care in the art of plowing, farmers may be able to keep the insect in check and thereby avoid more expensive and less easily applied methods of control. If a field is so stony, if the plow sole is so shallow, or if the plow equipment at hand is so poorly adapted that a clean job of plowing can not be done, the field still can be rendered safe if the operator will pick up scattered trash that appears on the surface. But the necessity for hand picking should be reduced to a minimum; the plowing should be so well done that little, if any, hand picking will be necessary. If the plowing equipment can not handle whole stalks, the operator still has the option of raking and burning the trash before plowing. If the plows at hand can not handle high stubble well, there is still opportunity of breaking the stubble over before plowing.

At first these plowing requisites may seem severe, yet many plowmen have been surprised at the ease with which the requirements can be met if proper attention is given to the care, set, and adjustment of the plow, and if simple, special covering attachments are properly used. Figure 32 shows what can be done by a farmer who has mastered tractor-plow adjustments. Better plowing must start with a good understanding of some of the fundamental principles of plows now on farms.

A bulletin on Plows and Good Plowing, by C. O. Reed and E. A. Silver, has been issued by the agricultural extension service of the Ohio State University. This bulletin covers the care, operation, and adjustment of the common types of walking, riding, and tractor plows; it contains valuable trouble indexes. Every plowman should study it. In 64 pages it covers the important subject of plows in a much more explicit and complete manner than is possible herein.

If you wish a copy, write to the Agricultural Extension Service, Ohio State University, Columbus, Ohio.

To facilitate reference the following information on plows is classified below:

	Page		Page
General points regarding plows and plowing-----	20	2-3 wheeled tractor plows with semi-floating hitch-----	44
Walking plows-----	21	2-wheeled tractor plows with semi-floating hitch-----	46
Two-way sulky plows-----	33	2-wheeled tractor plows with rigid hitch-----	48
Low-lift (frameless) sulky plows-----	40		
High-lift (framed) sulky plows-----	41		
3-wheeled tractor plows with full floating hitch-----	42		

After reading "General points regarding plows and plowing," immediately following, turn to the type of plow you have and read there the material devoted to your plow. Be sure to study all of the references given under the type in which you are interested.

GENERAL POINTS REGARDING PLOWS AND PLOWING

CONTROLLING FACTORS

Excluding such considerations as the ability of the plowman and the kind of soil, good plowing depends upon the major factors of: (1) Plowing when the condition of the soil is right, (2) the type and shape of plow bottom, (3) the relation between the depth of plowing and width of plow, (4) the correct width of furrow slice for the plow at hand, (5) keeping the plow bottom in normal position with relation to the furrow slice, (6) speed, (7) previous surface treatment, and (8) the proper care, set, and adjustments of the plow.

RELATION OF DEPTH AND WIDTH

Usually a common plow bottom is designed to do its best work at a depth equal to one-half its normal width when operated at normal speed under good plowing conditions. This does not mean that an 18-inch plow will not work well when plowing 5 inches deep, or that a 12-inch plow will not do good work when plowing 8 inches deep. It simply means that, departing from the ideal depth-width relation, poorer work and poorer trash covering may result. However, if you use a wide-bottom plow in soil which has not previously been plowed deep be very cautious about how rapidly you drop into the old plowsole. Unless you are sure that no ill effects to the productivity of the soil will result it may be best to take three or four seasons to increase the depth of plowing 2 or 3 inches.

INFLUENCE OF WIDTH

Usually a common plow bottom is designed to do its best work when plowing its normal width, if operated at normal speed under good plowing conditions. If you do not know the size of your plow, your dealer should be able to tell by the number of the plow or by the number of the moldboard and share.

Much has recently been heard about wide-bottom plows for corn-borer work. Experience on many farms has proved that even under severe conditions excellent jobs of trash covering can be accomplished with 16-inch and 18-inch bases, especially in soils in good state of tilth. The consensus of opinion seems to be that, generally speaking, it is easier to cover trash with the wider bases. With some

limitations, however, excellent jobs of trash covering can be accomplished with the smaller bases if the plowman will use care and patience. At least there is chance for a considerable improvement in plowing with the bases which are now common and which farmers may not yet be ready to displace.

In plowing under corn stubble a 12-inch or a 14-inch plow, properly equipped, will usually handle stubble up to a height equal to the width of the plow bottom. If the stubble be higher, see "Breaking over and rolling," page 18. In plowing under a light growth of whole stalks a 1-bottom 12-inch plow or a 14-inch gang plow properly equipped usually will do good work. As the stalk growth gets heavier these smaller widths of bottoms, especially of the gang type, are likely to become more troublesome, until in very heavy growths the 12-inch gang plow often fails because of lack of sufficient clearance between the bottoms. Fourteen-inch gangs properly equipped are often used successfully in fairly heavy growths, especially if the stalks are well broken over and lie in the direction of the plowing. If the plowman feels that his plow will not handle whole stalks satisfactorily, he still has the opportunity of raking and burning the stalks before plowing.

INFLUENCE OF KEEPING PLOW BOTTOM IN NORMAL POSITION

Each plow base is designed for a definite relative position in respect to the furrow slice. Poor condition, poor sets, misadjustments, or hitches which actually force the plow bottom from its correct position threaten to lower the quality of work and cause poorer trash covering. Throwing a plow "on its nose," winging it up or down, excessive side draft—all of these tend to rob the moldboard of its ability to handle the furrow slice as it is designed to do. Poor sets and misadjustments not only affect granulation, furrow slices, crowns, and scouring, but also may cause trash to pitch so that it can not be covered properly.

INFLUENCE OF SPEED

A plow bottom is designed to do its best work under good plowing conditions at a speed normal to the kind, shape, and size of bottom. The normal plowing speed of horse plows is about 2 miles per hour and that of many tractor plows about $2\frac{1}{4}$ or $2\frac{1}{2}$ miles per hour. Special speed bottoms have been designed for tractors, operating at 4 miles per hour. The proper speed may vary somewhat with the seasons and soil conditions, and slight changes in speed may have marked effects. If a plow is run too slow or too fast, it may not handle the furrow slice well, granulation may be adversely affected, trash covering may be poor, nonscouring may result, and there may be an objectionable difference in consistency between the upper and lower layers of the turned furrow slices. Speed is important from several standpoints. Give it attention.

WALKING PLOWS

The walking plow should be in such condition and be so set or adjusted that it will run without much guiding by the operator, unless he is plowing in stony or stumpy ground, where heavy trash abounds

or where the soil conditions vary materially. Unless the plow has a bent beam, bent frog, or badly worn landside, such an ideal set is possible in all common, serviceable walking plows if the operator will secure and maintain the proper down suck, land suck, wing bearing, sharpness, hitch, and set and condition of beam wheel, jointer, colter, and special covering devices.

DOWN SUCK AND LAND SUCK

The points of all walking-plow shares dip down slightly below the plane of the underside of the landside, as shown in Figure 17.



FIGURE 17.—Plow shares have down-suck

This is known as down suck. The land suck, as shown in Figure 18, is the distance which the point of the share extends into the unplowed ground beyond the plane of the land face of the landside.

These "suck" features have very decided influence in holding the plow steadily to its depth and width. They also influence draft, quality of work, and effort on the part of the plowman.

Inasmuch as cast shares can not be forged, the operator has no control over the down suck and land suck of cast shares other than to supply new ones as wear robs the plow of these necessary features. Be sure, however, to supply the right kind, shape, and size of share for your particular plow. The operator need pay no attention to the down suck and land suck of new steel shares if he purchases the

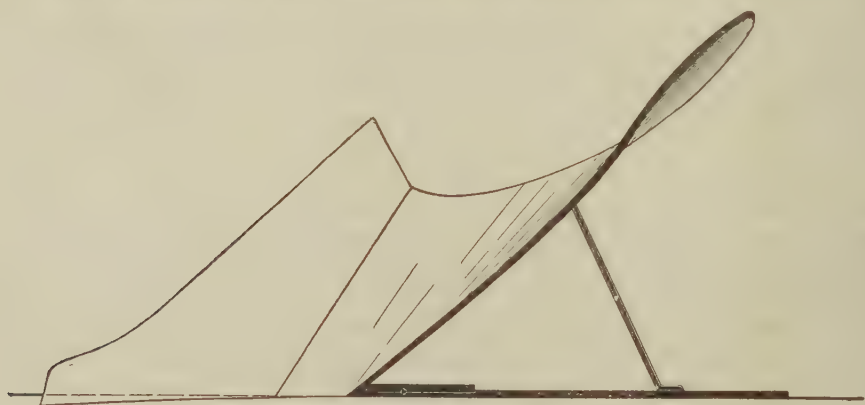


FIGURE 18.—Shares also have land-suck

right kind and size. However, in sharpening and in repointing steel shares by forging, great care must be taken to maintain the proper down suck and land suck in so far as these features are built into the share itself. Lay the finished steel share on a smooth surface as shown in Figure 19 and check up on the down suck at points A and B. Ordinarily, the clearance at each of these points should be very close to one-eighth of an inch. Sometimes for plowing ground that is very hard, in wide-cut shares, or in tractor plows, these clearances are increased slightly; but great care must be taken to bend the share

well back from the point, as at A and B in Figure 19, instead of simply bending the tip of the point downward. Be careful, too, not to put in too much down suck. If these two precautions are not heeded the plow will "bob"; that is, it will jump, gouge, run unsteadily, and even fail to hold its depth. After a steel share has been forged sharp or repointed, check up also on what land suck the share itself carries. Hold a straight-edge along its land face as shown in Figure 20. Ordinarily, the share would show from one-sixteenth to one-eighth of an inch clearance at C.

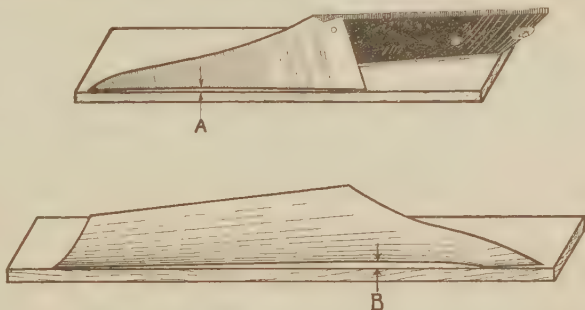


FIGURE 19.—Measure the down-suck of a new steel share. Know how much your shares should carry

The measurements for down suck and land suck vary slightly between plows of different makes and widths. If there is any question as to what measurements

the share of your particular plow should carry, measure a new share made especially for your plow. Preserve these figures, then give them to the blacksmith when you have the shares forged. Proper running of the plow depends also upon the perfect fit of the share, upon drawing the share down tight, upon replacing a badly worn landside, and upon supplying a new share when the old one has become worn back so badly that it is stubby. Excessive wear in both share and landside tends to upset the proper down-suck and land-suck features.

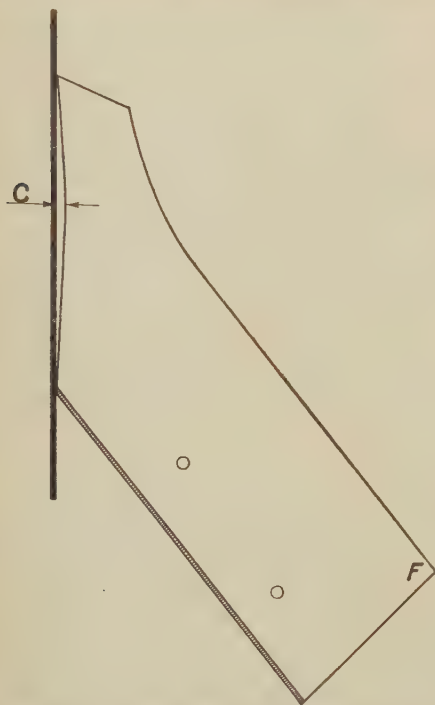


FIGURE 20.—Measure the land-suck which a new steel share carries. It will help when you have shares repointed

WING BEARING

The bottom or base of the walking plow has two bearing surfaces to work against the bottom of the furrow. Part of the down thrust of the plow is carried by the heel of the landside shown in figure 21; part is carried by

the flattened portion of the outside corner of the share at W. Hold a straightedge across the bottom of plow (fig. 21), so that it rests on heel of landside and on wing of share. The length of contact between the wing and the straightedge at W is the wing bearing. This feature in walking plows is extremely important and often

misunderstood. If the plow has too much wing bearing the plow will not suck in properly on the wing side, and we say the plow "wings up." It then tends to run narrow or "out." If the plow has too little wing bearing, it "wings down" or tends to run "wide." We want more wing bearing in walking plows when the soil is mellow than when the ground is hard and compact. Obviously, a walker with the proper amount of wing bearing to run level in fall plowing may wing down in spring work, or a walker which worked perfectly in the spring may act badly when the same share is used in the fall. If a walker tends to wing up or wing down, and if the operator attempts to overcome the difficulty by setting the hitch over, or if he overcomes the tendency to run wide or narrow by fighting the plow through the handles, then the plow bottom may not be kept level in its proper relation to the furrow slice. This condition has a marked effect upon trash covering and quality of work. A plow which wings up and is then pulled back to its width by the hitch is almost sure to pitch trash in such a way that the trash will lie close to the surface or will appear on the surface. Hence, in addition to its influence on

quality of work, wing bearing in walking plows is of extreme importance from the standpoint of corn-borer control.

For average plowing conditions regular steel shares on walking plows should carry wing bearing approximately as follows: 12-inch walkers, three-fourths inch; 14-inch walkers, 1¼ inches; 16-inch walkers, 1½ inches. Wing bearing on cast shares can not be changed, except that it can be lessened by carefully chipping off a little

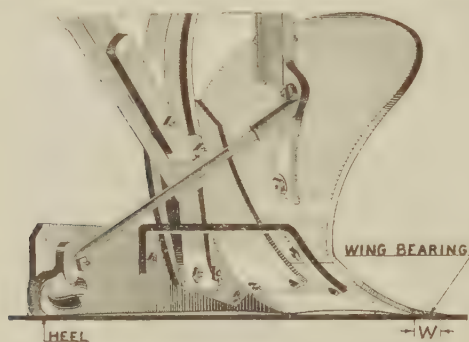


FIGURE 21.—The amount of wing bearing in walking plows is very important

of the wing. Wing bearing on steel shares can be increased or decreased by forging, or by carefully bending the wing slightly up or down with a well closed monkey wrench when the share is cold.

SHARPNESS

A blunt point, a dull cutting edge, or a badly worn wing will not only upset the proper running of the plow but will also increase draft. Usually all three of these bad conditions exist in the same share at the same time. A blunt point and a dull cutting edge in a cast share may be slightly and very temporarily remedied by chipping, or the point and cutting edge can be ground. However, trying to get along with a worn-out cast share is a hard task. Considering draft, quality of work, and one's time, it is doubtful if such a practice pays. Crucible-steel shares may be filed, ground, or forged sharp; but soft-center steel shares should not be filed or ground; they should be forged only. If the point and wing of a steel share are badly worn back, but the body of the share is still serviceable, new steel should be added by the regular repointing and rewinging processes, care being taken to maintain the proper down suck, land suck, and wing bearing as previously described.

Do not throw away steel shares, especially soft-center steel shares which can profitably be repointed, rewinged, and sharpened. Space here does not permit description of these processes. If you are not equipped to perform the work, take your shares to a good blacksmith and give him the dimensions you have for down suck, land suck, and wing bearing. If you are near the factory that built the plow, perhaps it will be best to return steel shares to the factory for re-dressing. In any event, remember the importance of sharpness and of maintaining the proper sets in the share.

HITCH

VERTICAL

When a plow bottom is working, its center of load or center of resistance, for all practical purposes, may be considered an imaginary point 2 inches from the shin of the plow and just below the surface of the ground, as indicated by C in Figure 22. Suppose you could fasten one end of a string to the center of resistance; then you passed the string through the pin that fastens the horizontal clevis

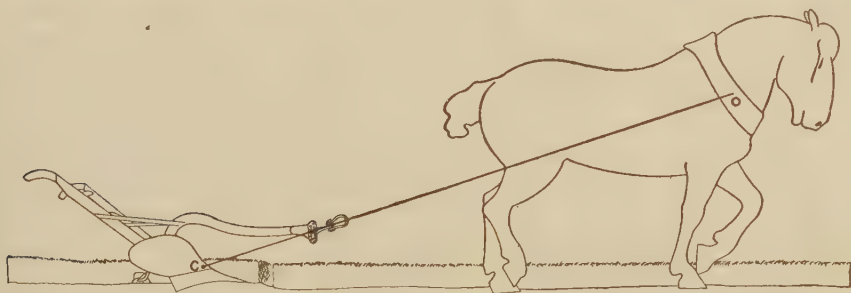


FIGURE 22.—For ease, good work, and steady running, keep the line of hitch as straight as possible

at the bridle of the plow; then you pulled the string tight as you held its other end at a point about 3 inches above the hame hook on the furrow horse's collar. The string would illustrate the line of hitch; this is indicated by the heavy line in Figures 22, 23, and 24.

If a walking plow is to run properly under good plowing conditions, the line of hitch in the vertical plane should be straight, as shown in Figure 22. Keeping the plow in good working condition, as described previously, and getting the hitch at the right height on the plow bridle are the chief factors under the operator's control by which he can keep the line of hitch straight.

If the hitch is too high or too low, the plow will tend to weave, the operator will have to fight it, the bottom may not be held in proper position in respect to the furrow slice, and poor quality of work and poor trash covering are apt to result.

HORIZONTAL

Now, let us consider the line of hitch in the horizontal plane; that is, looking down upon it as illustrated in Figures 23 and 24. The

point of application of the force of a 2-horse team, for all practical purposes, may be considered at F, halfway between the horses' collars. In a 3-horse team it would fall, for all practical purposes, at the center of the middle horse's collar. If the plow is to run steadily and without guiding under good plowing conditions with the plow in good shape, the line of hitch in the horizontal plane should be straight, as indicated by the solid line in Figures 23 and 24.

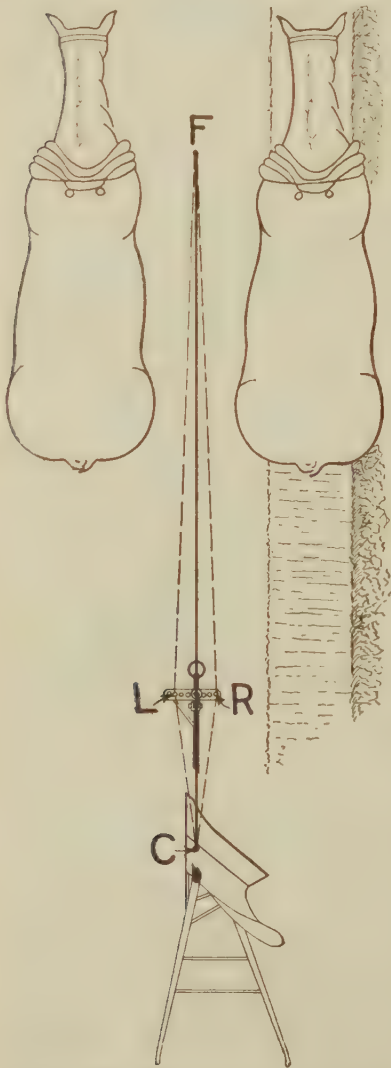


FIGURE 23.—The line of hitch should be straight horizontally as well as vertically. Hitching too far to left or right will break it

If the hitch is too far toward the unplowed ground, or too far toward the open furrow, as indicated by the dotted lines, the operator will have to fight the plow; the plow will not run steadily, the plow bottom may not be held in proper position in respect to the furrow slice, and poor quality of work and poor trash covering may result.

Frequently a doubletree or 2-horse evener which is too long is used. When two horses are used on a walking plow, and when the plow is cutting its normal width of furrow, the length of the doubletree between the outside holes should be as nearly as possible 32 inches for a 12-inch walker, 38 inches for a 14-inch walker, and 44 inches for a 16-inch walker. Then the two horses should be reined so that each walks straight ahead. Three horses should be so reined as to avoid crowding.

BEAM WHEEL

The beam wheel, or gage wheel, is necessary where an even depth of plowing is sought throughout a field containing a variety of soil conditions or hard and soft spots. It is advantageous, also, when a rolling colter is used. Under such conditions set the hitch high enough to secure the desired depth in that part of the field where the ground is the hardest; lower the beam wheel until it touches the surface of the ground lightly, then raise the hitch one hole. The line of hitch will then hold the plow to its depth through the hard spots, and the beam wheel will keep it from running too deep through the softer spots. When not needed the beam wheel is apt to become a useless source of repair expense and even a disadvantage from the standpoint of the team. Too many operators use the beam wheel

instead of the line of hitch to control depth. If one uses the beam wheel to gage the depth of plowing, and then is careless about the height of the hitch, he may be forcing the beam wheel to carry the down thrust of a broken line of hitch, and heavier draft will result.

If the beam wheel is used under good plowing conditions, secure the depth of plowing by the hitch; lower the gage wheel until it touches the surface of the ground; then raise the hitch one hole.

JOINTER

The jointer cuts out a narrow, shallow ribbon of soil just above and a little ahead of the plow. In so doing it performs four very important functions. Any trash which it can handle is moved over on the furrow slice toward the plowed ground in position to be buried deeper; a little soil is thrown on top of the trash to lessen its tendency to pitch; the removal of the ribbon of soil materially aids in preventing trash from appearing in the creases between the turned furrow slices; and the use of the jointer often reduces the air spaces under the slices.

Care must be taken to set the jointer properly and to keep its point full and sharp. When the jointer is used without a rolling colter standard rules for joint-

er set are: Move the jointer forward or backward on the beam until the point of the jointer is approximately over the point of the share; raise or lower until the point of the jointer cuts from $1\frac{1}{2}$ to 2 inches deep; adjust the jointer shank at the beam, or turn the jointer proper on its shank, until the point cuts from three-eighths to five-eighths of an inch "to land"—that is, from three-eighths to five-eighths of an inch farther into the unplowed

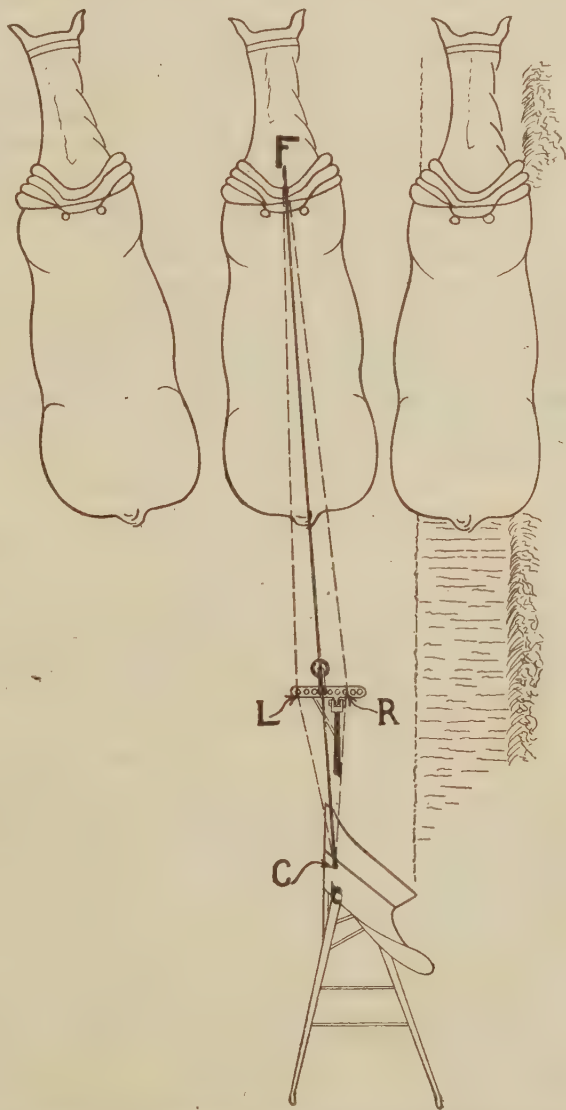


FIGURE 24.—Breaking the line of hitch may force the operator to fight the plow, and the implement will not run steadily

ground than the shin of the plow. The above rules are for small jointers. They also hold for large jointers, except that these usually are set a little deeper. Slight variation from these standard rules is sometimes necessary. On rough ground a slightly deeper set may be advantageous. Setting the jointer deeper usually causes it to throw more soil on top of the trash and to throw its own slices a trifle farther. Pitching the jointer down—that is, causing it to set at a greater angle to the ground surface, or setting it to cut slightly more to land, will often overcome nonscouring in the jointer itself. If set too flat, the jointer will not cut cleanly. All of these adjustments have rather marked effect, and, starting with the standard set given above, the operator may do well to experiment intelligently and systematically until he finds the best combination of sets for the surface and soil conditions at hand.

The jointer can be used alone in short trash which is either loose or fast; but, unfortunately, it clogs badly when used alone in long trash. It is helpful in plowing under corn stubble where there is not much long trash between the rows. In plowing under whole stalks the jointer, if used, should be accompanied by a rolling colter, unless some other equally effective device is used in combination with the jointer.

COLTERS

STATIONARY, STANDING, AND KNIFE COLTERS AND CUTTERS

Keep colters sharp, and keep the plane of the blade parallel to the plane of the landside. If a stationary or knife cutter or colter becomes bent to lead into or out of the land, shim it to lead straight. With the exception of “fin” cutters, stationary colters and cutters are not well adapted to heavy trash conditions.

ROLLING AND CASTER COLTERS

Rolling colters are so effective in long or heavy trash, and so valuable in getting corn-crop debris under, that manufacturers are now supplying light rolling colters for walking plows as well as larger colter blades for riding and tractor plows.

The rolling colter performs three important functions: It helps cut the furrow slice free vertically, thus assisting in securing a clean-cut furrow wall, and usually lessening draft; it cuts through trash which otherwise might drag on the shin and beam; and by cutting the trash into shorter lengths, it enables the plow bottom to cover better.

The set of the colter is extremely important. For ordinary plowing conditions move the colter forward or backward until its bearing is approximately over the point of the share, as shown in Figure 25. In stubble plowing lower the blade until it cuts from one-half to two-thirds the depth of the furrow, and five-eighths of an inch to land; that is, five-eighths of an inch farther into the unplowed ground than the shin of the plow. In sod plowing lower the blade to cut from two-thirds to the entire depth of the furrow and one-half of an inch to land. These are standard rules for colter set. They can not be adhered to strictly for all conditions, as is indicated in the next few paragraphs. Under adverse or unusual conditions the plowman may

do well to experiment until he finds the best combination of sets for his conditions, but he should keep as close to the standard rules as possible. How close he can adhere to the standard rules depends somewhat upon how perfectly the plow is adjusted at all other points.

The furrow wall will break badly if the colter is not set properly "to land." To avoid furrow wall breaking in loose soils, try setting the colter blade well forward and deep.

In plowing very hard ground the colter may have to be raised from standard set and moved back slightly on all types of plows except 2-wheeled tractor plows which carry rigid hitches, and on 2-way horse plows; on these move the colter ahead, if possible. In plowing where flat stones abound it often becomes necessary to set the colter well ahead and to the full depth of the furrow.

In deep plowing, or in plowing where heavy trash abounds, colters often must be run higher than the standard set provides for, in order to prevent trash from dragging at the bearing and shank and to permit the colter to mount the trash. This adjustment involves size of colter blade as well as set. To cut through trash a colter must have something to cut against; the soil furnishes the resistance. But before the colter can cut it must get hold of the trash—it must mount

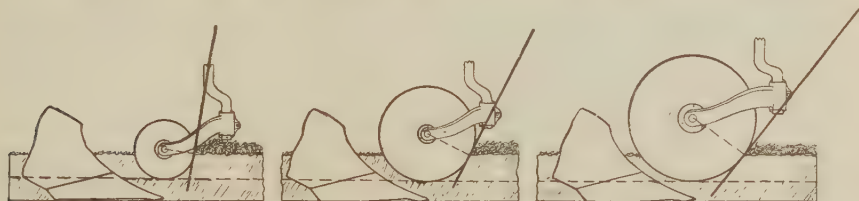


FIGURE 25.—Large colters can mount trash more readily than small ones

the trash instead of pushing it ahead. Hence, for any trash condition, the colter must be high enough to have good mounting ability, yet low enough to encounter sufficient resistance against which it can cut through the trash. Also, it should be low enough to leave a clean-cut sharp furrow wall. Obviously, a large colter blade set 4 inches deep will have better mounting ability than a small blade set at the same depth, as shown in Figure 25. Or, the larger the blade, the deeper it can be set and yet maintain trash-mounting ability.

These points are of vast importance in plowing for corn-borer control. The tendency is to use larger rolling colter blades. One of the great difficulties with the old rolling colters at present on all types of plows is that many of them are worn back to small diameters, some less than 10 inches. To successfully handle heavy trash use a standard rolling colter blade as large as conditions will permit, one of these conditions being that you must maintain sufficient clearance between the blade and other parts of the plow. If possible use 14-inch or 16-inch blades, and even 18-inch blades on the wider bottoms. Of course, a small colter may have better penetrating ability than a large one in hard ground, and it may roll faster than the large one, yet the effectiveness of the rolling action in cutting trash depends largely upon the blade getting hold of the

trash. A moment's reflection on these principles will indicate the necessity of keeping both large and small colters sharp.

Keep colters sharp with a good flat mill file of about 12-inch size. Sharpening on an emery wheel is often resorted to, but be careful not to bear on so hard or turn the emery wheel so fast that you draw the temper of the blade. Take care of the colter bearing or repair it to prevent wobbling. Some colters carry cone bearings, which can be drawn up slightly as wobbling develops due to wear. When working, the rolling colter should stand vertically. If it runs at an angle from the vertical, trouble is almost sure to result. This has foiled many good plowmen; watch out for a badly worn bearing, a bent yoke, a bent shank, or excessive play between the yoke and shank.

COMBINATION JOINTER AND COLTER

Although not common on walking plows, the combination of jointer and rolling colter is so advantageous for trash handling that a special, light combination is making its appearance for walking plows. The advantages of the jointer can be enjoyed in heavy trash if the jointer is accompanied by the cutting action of the rolling colter.

When the colter and jointer are used at the same time standard rules for jointer set and standard rules for colter set, previously given, are followed as closely as possible, except that the colter may have to be set slightly forward and the jointer set back in order to give trash clearance between the jointer and the colter bearing. Be sure to keep the point of the jointer very close to the blade of the colter in order to avoid trash catching. Ordinarily the clearance between the shin of the jointer and the colter blade increases from zero at the point of the jointer to about three-eighths of an inch at the top of the jointer shin. Do not discard the jointer simply because it catches trash when used with a wobbling colter; repair the colter.

SPECIAL COVERING DEVICES

CHAIN

Probably the most common auxiliary covering device used on walking plows is the log chain. One end of the chain is fastened to the doubletree at the furrow horse's clevis, as shown in figure 26. The other end is fastened to the plow beam at the jointer shank, where the handle braces attach to the beam, or at a point on the beam about 10 inches back of a vertical line through the point of the share. The chain is long enough to form a loop which drags on the surface of the turning furrow slice. In this position the loop keeps trash from pitching, it helps straighten the trash, and folds it under as the slice is inverted. A little experimenting may be necessary to determine the exact points at which to fasten the chain and its proper length for the conditions at hand. Some operators lengthen the chain until its loop is pinched slightly by the falling furrow slice. Others tie a simple knot in the chain at the low side of the loop in order to have the chain held properly. Sometimes a short piece of wire is fastened to the chain at such point that the wire, in dragging under the turned slice, will hold the chain in the desired position. The

chain is very valuable in fairly high, fast trash; it is often a great help in stubble. It may assist materially in twisted, whole corn-stalks; but under this latter condition it should be accompanied, if possible, by other covering devices, such as jointer or colter. The chain can be used on single-bottom riding and tractor plows, although on wheeled plows, especially gangs, covering wires usually are used in place of chains.

COVERING WIRES

The covering wire as an auxiliary covering device is not usually advocated for walking plows, because, unless care is used in its attachment, the wire tends to pull the walker from its normal position. The wire, however, has considerable merit, and there is opportunity



FIGURE 26.—The log chain, properly adjusted, is a great help in trash covering

for its wider adaptation to walking plows, especially in combination with the chain, the jointer, or the colter. Try it; it may be just the thing for your particular condition, even though your neighbor may not like it.

The covering wire is simply a piece of No. 9 soft-iron wire about 6 to 8 feet long for walkers and about 10 to 12 feet long for wheeled plows, the length depending upon the point at which the wire is to be fastened to the plow. One end is fastened to the plow ahead of the plow bottom at such a point as will permit the wire to drag across the surface of the furrow slice just as the slice is being turned by the plow bottom. The other end of the wire drags under the newly turned slice; the weight of the turned slice holds the wire tight. When properly placed, the wire holds the trash tight against the turning furrow slice; it keeps the trash from pitching; it materially aids in

folding the trash under. If the wire is not held tight enough, supply one a little longer or bend up the rear end just a trifle. Do not bend the end enough to catch trash; do not put a hook in the end. If the wire breaks, supply a new one. Do not splice at any point where trash can catch.

When the rolling colter is used alone, or in connection with the jointer, a good way of attaching the wire is shown in Figure 27. Notice that the wire passes over the colter bearing, inside the arm of the yoke, out the underside of the yoke, and up to the beam. The forward portion of the wire helps feed trash down below the colter shank. Sometimes the wire is fastened directly to the colter yoke close to the colter bearing; sometimes to the lower end of the colter shank. When the jointer is used alone, or when neither rolling colter nor jointer is used, the wire is usually fastened to the beam just back of the plow bridge. Some plowmen clamp a piece of strap iron around the beam, the strap extending downward from a point approximately over the point of the share; the wire is fastened to this. The strap can be bent slightly, raised or lowered, or moved forward or backward until the best position is determined.

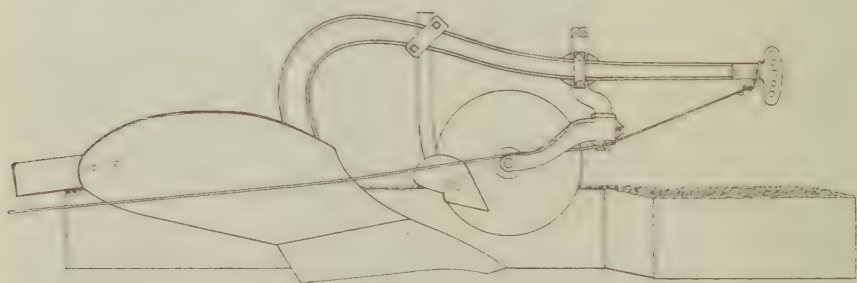


FIGURE 27.—A good method of attaching a covering wire. Note also the moldboard extension, or "flipper."

Sometimes two or even three wires per plow are used. Five wires per plow bottom have been used on tractor gang plows, the wires being fastened to a strap iron clamped well forward on the underside of the beams. In plowing for corn-borer control the covering wire is extremely important. Under some conditions it means the difference between good and poor trash covering. Its position and use vary with conditions. Get clearly in mind its function as described in the preceding paragraph, then experiment with it systematically and patiently until you determine fully just how to place it.

WEED HOOK

The use, shape, position, and adjustment of weed hooks is familiar to most plowmen. Ordinarily the weed hook does not rank in importance with the covering devices mentioned above. Some farmers, however, are imitating the weed hook by clamping to the beam a heavy piece of band iron, similar to wagon-tire stock. The iron has a shape very similar to that of a weed hook, and is so placed that it draws the trash ahead slightly and folds it under just as the furrow slice lays over.

MOLDBOARD EXTENSION

The moldboard extension, shown at the wing of the moldboard in Figure 27, under some conditions is very valuable in laying the furrow slice over farther, and thus helping to bury trash deeper in the creases. The moldboard extension, or "flipper," is becoming quite common on wheeled plows; plows are appearing on the market with the holes already drilled in the moldboard for the attachment of the extension. Although the extension is not often used in this country on walking plows, nevertheless there is opportunity for it. If your walker or wheeled plow carries a cast moldboard which is not drilled for the extension, you should not attempt to drill it. There is some possibility of drilling a steel moldboard, but this should be done only by a competent blacksmith or machinist who is familiar with the handling and treatment of plow steels. The extensions can be purchased as extras. They are adjustable. A sample can be seen in nearly any dealer's store where tractor plows are sold.

TWO-WAY SULKY PLOWS

A 2-way sulky plow is a 2-wheeled plow which throws the furrow slice to the right or to the left, depending upon whether the right-hand base or the left-hand base is down in working position. Each beam is fastened to a saddle casting which rides a bail attached to one wheel. The principles of the hitch are similar to those of the walking plow; yet the 2-way sulky embodies several riding plow principles inasmuch as the plow bottoms are carried on wheels.

The proper running of the ordinary 2-way sulky plow depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), sharpness (p. 24), fullness at the wing, levelness, width, depth, hitch, length of evener, reining of horses, length of traces and adjustment of neck yoke, heel pressure, land-side pressure, hitch shift, control and adjustment of wheels, and the set and condition of jointer, colter, and special covering devices.

In applying the following information the operator must remember that often the two plow bottoms can not be set exactly alike to secure identical performance. The work of each plow unit is affected by the characteristics of that unit, and there may be some slight differences between bottoms, beams, bails, beam castings, levers, quadrants, wheels, and clevises. Also, each bottom is used with a different horse in the open furrow. Therefore, adjust the plow units independently of one another until the work of the two is as similar and ideal as conditions permit. Obviously, unequal wear in shares, colters or jointers not being set alike, one plow plowing deeper or wider than the other, and the plows not being carried at similar angles may lead to variations in performance. Good plowing consists of furrow crowns of equal height and curvature, and of uniform granulation, as well as of good trash covering and straightness.

FULLNESS AT THE WING

Inasmuch as the down thrust of the plow bottom is carried on the wheels, instead of on the heel of the land-side and on the wing of the share, no wing bearing is necessary in riding plows. However, in

repairing steel shares, care should be taken to keep the wing full (F in fig. 20), and to avoid putting in the wing bearing described on page 23. Renewal of cast shares is important from the standpoint of maintaining wing fullness as well as to secure the proper down and land sucks.

LEVELNESS

The depth lever is the lever that controls the plow bottom which is working, no matter which base is down. The leveling lever is the lever controlling the idle bottom. To maintain even depth, keep the wheel, which is in the furrow, running on the same plane as the cutting edge of the working bottom; then, by the leveling lever, keep the frame of the sulky parallel to the surface of the ground in which the plowing is being done. This is known as leveling, but, of course, when working on slopes levelness must be interpreted as meaning parallel. If the plow bottom is not held in this position, it is running either winged up or winged down; it tends to lead out of or into the land, and the bottom is not being held in its normal position in respect to the furrow slice. Such misadjustment has decided bearing on trash covering, as well as on evenness of depth, evenness of furrow crowns, and draft.

Poor adjustment or set of the levers, however, is not the only cause for bottoms being out of level. Excessive slop, due to wear or looseness between the beam and its saddle casting, or between the saddle casting and bail, must be eliminated in order to bring each bottom as much as possible under the positive control of its lever.

WIDTH

Operators are familiar with the width change adjustments found usually in the saddle castings, but attention is again called to "Relation of depth and width" and to "Influence of width" on pages 20 and 21.

Too strong emphasis can not be placed on the fact that in level-ground plowing the width should be controlled by the proper set of beams on bails, by the hitch, and by the necessary evener changes. In other words, these factors, as in the walking plow, should control width without forcing the operator to angle the wheels solely to control width. In sidehill work the wheels may have to be angled to hold the plow to its width, but the necessity for such angle should be caused only by the plow's tendency to shift downhill; it should not be caused by misadjustment of the hitch. See Hitch following.

Before changing colter or jointer set to secure conformity of furrow crowns be sure that the plow bases are cutting equal depths and widths.

DEPTH

As stated previously, uneven furrow crowns may result if the bottoms do not work at the same depth in each successive furrow. Unlike depths may be caused by the operator failing to set the levers in the same position each time he sets a bottom. If he does set the levers in the same notches in the lever quadrants and finds that one bottom is plowing deeper than its mate, he may need to advance or retard one quadrant in respect to the other. This is possible in some plows

by a device found at one end of one quadrant, in the links, or in the quadrant supports.

Failure to follow the rules given under "Levelness" (p. 34), may cause the plow to run a little deeper or a little shallower in each successive furrow. Conversely, if the soil is so loose that the plow tends to run deeper in successive furrows, try running it high on the land side; that is, throw it out of level (or off the parallel plane) by raising the frame on the land wheel by means of the leveling lever. If the ground is so hard or stony that each furrow is shallower than the preceding one, try running the frame low on the land side. Sometimes these special sets help materially, but if the latter leads to poor trash covering it is not to be recommended from the standpoint of corn-borer control.

HEIGHT OF HITCH

Although Figures 22, 23, and 24 show walking plows, they are equally adapted to this hitch discussion on the 2-way plows, and frequent reference will be made to them. The heavy black line from the horse's hame to the center of resistance (fig. 22, C) is the line of hitch in the vertical plane (par. 2, p. 25). Line FC in Figures 23 and 24 is the line of hitch in the horizontal plane (par. 5, p. 25). The line of hitch always passes through the clevis pin which connects the eveners to the bridle of the plow, providing the clevis is free to swing about the pin, as is usually the case in horse hitches on plows.

Height of hitch is extremely important on 2-way plows, especially from the standpoint of draft, quality of work, and penetration. In normal-ground plowing, with shares and landsides in good condition, adjust the hitch shift device on the vertical clevises on the plow beams at such height that the heel of the landside is pressing against the bottom of the furrow very lightly when the plow is plowing at the depth desired. Breaking the line of hitch downward, by having the point of contact between team and plow too low, will increase draft by increasing heel friction if the heels are not badly worn; it will increase the force downward on the horses' necks; it will cause wheels to lose traction on slopes and may cause failure to penetrate. Breaking the line of hitch upward, by having the hitch too high, will "throw the plow on its nose," cause heel clearance, increased suck and heavy draft, and the plow may bob instead of working steadily at its depth. Furthermore, a bottom run in this way is not held in its normal position in respect to the furrow slice, and poorer work and poor trash covering are very likely to result.

There is a tendency on the part of operators to use shares long after they have passed the point of good service. In an attempt to make up for loss of suck in stubby shares they raise the hitch. This may not always be good economy. The increased load on the team may slow up the plowing process to the point where loss in man and horse labor far exceeds the cost of shares. It should be remembered, too, that pitching a plow bottom downward beyond the critical point of suck will cause the base to lose its penetrating ability very quickly; the plow will then bob, gouge, run unsteadily, and lose its depth.

When the depth of plowing is changed materially the height of hitch must be changed to meet the rules given in the second paragraph under this heading.

Two-way plows carry two types of devices to which the hitch shift bar is fastened. Some makes carry clevises; these seem to be common in New England, hence this discussion is confined to this type. The statements and principles herein, however, apply equally well to both the vertical and horizontal hitch adjustments in the dial-hitch type.

HORIZONTAL ADJUSTMENT OF HITCH

The horizontal adjustment of the hitch is important from the standpoint of width control, draft, and quality of work. The hitch shift bar is usually held by clevises which pivot; these allow the evener clevis to swing a little as soon as the team picks up the load after the hitch has shifted automatically. But considerable care must be taken to set the limits which may control the final position of the clevis evener. Move the end clevises on the plow beams a little closer together or a little farther apart on the beam bridges until the evener clevis can take such position that the line of hitch (figs. 23 and 24) is as straight as possible when the team is pulling and when the plow is set for the width of cut desired. In doing this the expert plowman goes a step further; he sets the beam clevises so that the evener clevis is held a trifle nearer the open furrow than just described, because he wants the line of hitch broken toward the furrow just enough to relieve slightly the pressure of the landside against the furrow wall. Generally such set, when properly made, lessens draft, providing the wheels do not have to be angled to offset the effect.

In attempting to set the hitch for narrow or for wide plowing, the operator may conclude that sufficient range in the limits has not been allowed by the manufacturer. Most plows carry devices for increasing the range; often interchanging the horizontal clevises on the beams is all that is necessary, or inverting these clevises instead of interchanging them may give the results desired.

Some 2-way plows carry beams which are slightly offset; that is, the beams may incline a little to the right or to the left from a vertical plane through the landside. Do not let this confuse you. It is the line of hitch, not the beam, that should interest you. Keep the line of hitch as nearly straight as possible. Remember this is an imaginary line from the point of application of force (F in figs. 23 and 24) to the center of resistance, C , and it passes through the point of contact between the team and implement: this point of contact in 2-way plows may be considered the center clevis on the evener.

If the limits hold the hitch too close to the open furrow, the line of hitch is broken in that direction. Then the tendency of the line of hitch to straighten will tend to pull the plow into the land, width of cut will be upset, clearance may exist between landside and furrow wall, the plow bottom will not be held in normal position, the wheels may have to be angled to lead toward the plowed ground, and increased draft is almost sure to result.

If the limits hold the hitch too far to the land side of the plow, the plow will tend to lead out, friction between landside and furrow wall will be increased, and the wheels may have to be used to control width in violation of the rules given under "Width" on page 34.

Of course, side draft is sure to exist in any common width of sulky plow when its three horses are driven abreast and when one of the

outside horses walks in the open furrow. In many instances the wheels of the 2-way sulky may have to be used to absorb the side draft resulting from the 3-horse hitch even in level-ground plowing. In hillside work the wheels may have to be angled to hold the plow up the slope. But too much emphasis can not be placed upon the rule to get the hitch as nearly perfect as possible before using the wheels to overcome poor hitch adjustment.

Successful adjustment of the hitch depends also upon the relationships described under the next heading.

LENGTH OF EVENER, REINING OF TEAM, LENGTH OF TRACES, AND ADJUSTMENT OF NECK YOKE

Securing the proper hitch relations, as described under the preceding heading, depends to no small degree upon using the proper length of evener, whether this be a doubletree for two horses or a tripletree for three horses. By manipulating evener length, reining arrangement, and length of trace, the direction of the force exerted by any horse or by the combined team can be varied.

The operator may find it very advantageous to keep as close as possible to the dimensions for eveners given in paragraph 3 on page 26. When the 2-way plow is set to cut 10 inches wide the true line of draft of the plow for all practical purposes is assumed to fall approximately 13 inches from the center of the open furrow where the furrow horse walks. Some farmers use on their 2-way plows a special, homemade doubletree with a series of holes at each end, so that the singletree clevises can be attached in such way that the center clevis is over the true line of draft of the plow for any common width of plowing. Then, not only can the line of hitch be kept straight, but also it is approximately parallel to the open furrow: side draft is eliminated, and the team can pull straight to the front.

If a length of doubletree is used which permits the team to walk straight to the front, be careful to rein the horses so that each can walk in that direction. Rein the three horses, in a 3-unit team, to avoid crowding. Sometimes, even when the hitch is perfect, the furrow wheel keeps crowding over to furrow wall; yet the smallest adjustment allowed for angling the wheels is too great, if used, to overcome the difficulty without carrying the plow in the other direction. This trouble may be overcome by adjusting cross reins to draw the horses' heads a little closer together. Conversely, if the furrow wheel runs from the furrow wall, try adjusting reins so horses' heads are farther apart. (See also under "Wheels," p. 39.)

Be careful not to hitch too close. If traces are too short, neck yoke sliding will be hampered, difficulty may be experienced in raising the plows, and the hitch may not shift when it should at the headland. The rule with some plowmen is to lengthen the traces until the team can slack back slightly without backing the implement. If the pole carries a loop on which the neck yoke slides, adjust traces so that neck yoke is in the center of the loop when the team is pulling.

Excessive pole whipping handicaps an operator's attempt to maintain straight furrows. Keep neck yoke straps, or breast straps, short enough to bring the pole under good control. The use of martingales to keep the pole from tilting up is considered essential by some opera-

tors, the claim being that it brings the wheel or frame shifting device under more positive control.

HEEL PRESSURE

The heel of the landside should run lightly on the bottom of the furrow. This condition is controlled by the height of hitch as described on page 35. It is assumed, of course, that the beams are not bent, that landsides and shares are in serviceable condition and that the latter carry the correct amount of down suck. If the ground is unusually hard or excessively stony, if shares are too stubby to be serviceable, or if the heels are badly worn away, the rules for heel pressure can not always be followed.

LANDSIDE PRESSURE

The landside of each plow base should run against the furrow wall, but the degree of pressure can not easily be stated. If the operator will keep the line of hitch in the horizontal plane as straight as possible, as described under "Hitch" on page 36, the landside pressure will be about right for all practical purposes. The expert plowman may relieve the landside pressure slightly as described in the reference given.

In this discussion it is assumed that beams are not bent, that landsides and shares are in serviceable condition, and that the latter carry the proper amount of land suck. If beams are bent, if shares are badly worn, or if the landsides have become worn very thin, it may not be possible to follow rules for landside pressure.

If clearance exists between the furrow wall and the landside, troubles are apt to develop as described in the fifth paragraph on page 36, and the condition should be remedied by the adjustments described there.

Furrow wall breaking may result, and increased draft is very likely to result, if the landside pressure is excessive. To remedy this condition, see under "Horizontal adjustments of hitch," page 36.

If misadjustment of the hitch is not the cause for too much or too little landside pressure, see under "Wheel adjustment" on page 39. In sidehill work where the degree of slope or soil conditions vary, it is impractical, of course, to pay much attention to landside pressure after care has been exercised to adjust the hitch properly for the average condition.

HITCH SHIFT

Maintaining the proper position of the hitch horizontally depends somewhat upon the ease with which the hitch shifts and upon its shifting the entire distance to its new position. A quick, complete shift, in turn, depends largely upon the height to which the idle bottom is raised. In shallow plowing, when the leveling adjustment prevents the idle bottom from resting at its highest point, the operator may have to momentarily raise the beam to its greatest height until the hitch shifts, then level the plow. Slacking the team at the moment one expects the hitch to shift often helps.

Obviously, a bent shift rod or failure to grease the shifting mechanism may prevent full movement. The trouble may be caused, too, by the traces being too short, as described in paragraph 6, page 37.

CONTROL AND ADJUSTMENT OF WHEELS

Keep the wheels running parallel to the furrow wall as much as possible. To do this care must be taken to make the proper adjustments for width of cut (p. 34), to hitch correctly horizontally (p. 36), to use a doubletree of right length (p. 37), and to rein the horses properly (p. 37). Angling the wheels materially to overcome the effects of poor adjustment elsewhere is almost sure to increase draft.

If all sets have been made as ideally as possible and yet the plow seems to run more steadily when the furrow wheel is angled very slightly toward the furrow wall, try reining the horses so that their heads are a little farther apart. Drawing their heads a little closer may cause the furrow wheel to incline slightly away from the furrow wall. These means are resorted to by some operators to secure the slight effects desired without having to shift the pole at the beginning of each furrow. Such finer sets may mean little if the plow is working on hillsides or if three horses are being used.

In case an operator seeks under this heading for information on what he may interpret as wheel trouble, it will not be amiss to repeat instructions briefly from the standpoint of wheels. If the furrow wheel tends to climb the furrow wall or to run too close to it, see under "Width" (p. 34), and under "Horizontal adjustment of hitch" (p. 36). To remedy this condition the operator may have to place beam clevises slightly closer together or to adjust the cross reins to draw the horses' heads closer. If the furrow wheel tends to run away from the furrow wall or too far from it, see references just mentioned. For this condition it may be necessary to set beam clevises a little farther apart or to rein horses so that their heads are a little farther apart.

When a 2-way sulky is new, its wheels, like those of wagons and cultivators, carry both bottom gather and front gather; that is, the rims of the wheels are closer together at the bottom than at the top, and from 1 to 1½ inches closer together in front than at the rear. Space here does not permit discussion as to the reasons for gather, but a brief statement should be made concerning the seriousness of loss of front gather due to wear between hubs and axles as the plow ages. The loss of front gather tends to increase draft even when the furrow wheel is run parallel to the furrow wall; and when the wheels are angled the absence of front gather is very apt to cause an abnormal twisting action throughout the frame, tending to upset the proper width, landside pressure, and hitch relations. If the manufacturer has allowed any adjustments by which the gathers may be maintained within reasonable limits, the operator should take advantage of them. Otherwise, little can be done from a practical standpoint. But in estimating the serviceability of an old 2-way plow one should keep in mind the influence of the gather features on utility value.

PRESENCE, SET, AND ADJUSTMENT OF JOINTERS, COLTERS, AND SPECIAL COVERING DEVICES

Although rolling colters and special covering devices are not common on 2-way plows in New England, operators are requested to consider conscientiously the possibility of a wider adaptation of these

valuable devices from the standpoint of better plowing in corn-borer control. You may not be able to use the rolling colter in all of your fields, but you may be able to attach it in some, especially in the finer soils so commonly used for market gardening. Of course, the mechanical principles of 2-way plows vary some from those of tractor plows, but investigation shows that many operators, who a few years ago believed they could not be used, are now using rolling colters very successfully on tractor plows. They have found that good rolling colters can take considerable abuse from stones; that the rolling colter is well-nigh indispensable in heavy trash, and that it often protects the plow point. There is opportunity, too, for wider adaptation of covering wires to 2-way plows.

For description, function, and set of colters, jointers, and special covering devices, see pages 27 to 33.

Like the jointer, the rolling colter can be used alone on the 2-way; or the jointer and colter can be used at the same time. In using both, better success may be had by using independent units than by attaching typical combinations.

The rolling colter is usually attached to a 2-way plow by placing its clamp on the beam at a point ahead of the bail, but the clamp is moved well back so that the bearing of the colter will be as near as possible over the point of the share, as required in paragraph 6 on page 28. The tendency of colter blade is to raise the plow, but if the beam is locked down by the lever the weight of frame and operator helps hold the plow down. Then the force of the colter blade upward may tend to raise the plow bottom around the bail as a center, and the front end of the beam may drop. For this condition the hitch should be lowered a little instead of raised. If the ground is so hard or stony that lowering the hitch assists the colter in riding the plow high, move the colter forward to bring its bearing nearer a vertical line through the bail. Then the line of hitch in the vertical plane can be more nearly straight. This peculiarity of colter set in 2-ways is found in no other type of plow. It is described here in detail because it confuses some operators. Remember that in the 2-way plow the beam pivots on the bail.

LOW-LIFT (FRAMELESS) SULKY PLOWS

A low-lift, or frameless, sulky plow for use with horses is a single-bottom riding plow in which the wheels are attached directly to the beam. The beam is raised and lowered on the land wheel and on the front furrow wheel by means of levers. Ordinarily the relationship between the beam and rear furrow wheel is set and can not be changed. This feature, together with the absence of an extra frame, renders the implement a low-lift or frameless plow.

The proper running of the low-lift sulky depends largely on securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), width of cut, levelness, hitch, angle of front furrow wheel, and the set and condition of jointer, colter, and special covering devices (pp. 27-33).

WIDTH OF CUT

The front furrow wheel is supposed to run in the angle between the furrow wall and bottom of the open furrow. It is partly a guide

which helps hold the plow to its width. By the adjustment furnished for that purpose, move the furrow-wheel assembly in or out on the frame until the plow bottom is cutting its normal width. At this point attention is called again to paragraph 6, page 20; also to the third paragraph following.

LEVELNESS

After the desired depth of plowing has been secured, keep the front furrow wheel running on the same plane as the cutting edge of the share, and keep the frame or plow bottom level. This is one of the important ways in which you can keep the plow bottom in proper position in respect to the furrow slice. Failure to observe this rule may cause poor trash covering with all types of wheeled plows.

HITCH

The tendency of plowmen with all wheeled plows is to hitch too high. Keep the plow in good working condition, then hitch so that the line of hitch in the vertical plane (fig. 22) is as straight as possible.

If three horses are driven abreast on a 1-way sulky, keep the line of hitch in the horizontal plane (fig. 24) straight. Set the front furrow wheel to lead slightly toward the furrow wall—enough to keep the wheel against the wall, yet not enough to cause the wheel to climb the wall.

HIGH-LIFT (FRAMED) SULKY PLOWS

A high-lift or framed sulky plow for use with horses is a single-bottom riding plow in which a special frame forms the backbone. All three wheels attach directly to the frame instead of to the beam, and by means of a foot lift and bails the plow bottom and its beam is raised and lowered within the frame. The frame feature permits the plow bottom to be raised in respect to the rear furrow wheel; this renders the implement a high-lift or framed plow.

The proper running of a high-lift sulky depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), width of cut (p. 40), landside clearance, heel clearance, levelness (p. 41), hitch, angle of front and of rear furrow wheel, and upon the set and condition of jointer, colter, and special covering devices (pp. 27-33).

LANDSIDE CLEARANCE

Most high-lift horse sulkies and horse gang plows carry a landside on the plow bottom directly ahead of the rear furrow wheel. The rear furrow wheel should run tight against the furrow wall. Three-eighths of an inch clearance, or a close finger's width, should exist between the landside and furrow wall, as indicated in Figure 28, which shows also a common adjustment by which this clearance is maintained. If landside clearance and heel clearance are not maintained, the plow bottom will not be held in proper relation to the furrow slice and poor trash covering and heavy draft may result.

HEEL CLEARANCE

As the down thrust of a riding plow should be carried on the wheels, the heel of the landside on 3-wheeled high-lift horse plows should not ride the bottom of the furrow. A clearance of three-eighths of an inch, or a close finger's width, should exist between the heel of the landside and the bottom of the furrow, as indicated in Figure 28, which shows also by arrow a common adjustment to maintain heel clearance.

HITCH AND ANGLE OF FRONT AND OF REAR FURROW WHEELS

For directions regarding the hitch vertically see paragraph 3, page 41. If three horses are driven abreast on a 1-way, high-lift, sulky plow, keep the line of hitch in the horizontal plane (fig. 24) straight. Set the front furrow wheel to lead slightly toward the furrow wall, as described on page 41, and the rear furrow wheel set to lead very slightly away from the furrow wall.



FIGURE 28.—Proper heel clearance and landside clearance is easy to maintain

THREE-WHEELED TRACTOR PLOWS WITH FULL FLOATING HITCH

In a plow of this type, which may have one, two, three, or four bottoms, all three wheels carry the bottoms at all times. When the beams are raised and lowered they remain parallel to the surface of the ground because they are raised and lowered on the rear furrow wheel as well as on the front wheels. To secure this lifting action on the rear furrow wheel, a connecting rod, or lifting rod, runs to the rear furrow-wheel assembly from the lifting mechanism ahead. Such plows carry full floating hitch bars which float freely vertically. That is, the tractor and the plow are independent of one another in their up and down movement in passing over the rises and through the depressions of an uneven surface.

The proper running of this type of plow depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), levelness (p. 41), angle of rear furrow wheel, landside pressure, heel clearance, length of connecting rod, width of cut, side-draft relations, hitch, and set and condition of jointer, colter, and special covering devices (pp. 27-33).

ANGLE OF REAR FURROW WHEEL AND LANDSIDE PRESSURE

Instead of running against the furrow wall, the bottom of the rear furrow wheel of most plows of this type runs a slight distance from the wall, and the wheel is angled to lead slightly away from the

wall. Thus, the side thrust of the plow is partly cared for by the bearing surface of the land face of the landside, and partly offset by the rear furrow wheel running at a slight angle to the furrow wall. Ordinarily the rim of the rear furrow wheel at the front side (at a point level with the bearing) is set about five-eighths of an inch farther from the furrow wall than a similar point on the rear side. This distance varies a little among different makes of plows, and the adjustments which secure the angle are so varied that they can not be shown or described in detail here. Refer to the instruction book for your particular plow or obtain information from the manufacturer on what the angle should be and how it is maintained.

HEEL CLEARANCE

Some plows of this type are designed to run with the heel of the landside of the rear bottom touching the bottom of the furrow lightly; others carry about three-eighths of an inch clearance between heel and bottom of furrow. Maintaining the proper heel clearance is of great importance. Refer to the instruction book for your particular plow or obtain information from the manufacturer on what the heel clearance should be and how to maintain it.

CONNECTING ROD

Keep the connecting rod long enough to be idle or to carry no load while the plows are working, yet short enough to take hold as soon as lifting action starts.

WIDTH OF CUT

Adjust hitch bars so that the front plow bottom is cutting its normal width. Otherwise uneven furrow crowns will result. Quick shift hitches are an advantage in rolling fields.

SIDE DRAFT

If an outfit is being used in which the center line of pull of the tractor is some distance from the center line of draft of the plow, attach the clevis to the draw bar of the tractor approximately halfway between these imaginary lines. Then lengthen or shorten the adjustable hitch bar, as suggested in preceding paragraph, to cause the front plow to cut its normal width. If too much side draft exists in the tractor, move the clevis on the draw bar of the tractor a little closer to the true line of pull of the tractor; then lengthen or shorten the adjustable hitch bar to gain back the proper width of cut of the front bottom. If too much side draft exists in the plow, move the clevis on the draw bar of the tractor nearer the true line of draft through the plow; then lengthen or shorten the adjustable hitch bar to regain proper width of cut.

HITCH

Keep the plow in good working condition so that the line of hitch vertically can be kept straight, as shown in Figure 29. For adjustments horizontally, see the two preceding paragraphs.

TWO-THREE WHEELED TRACTOR PLOWS WITH SEMIFLOATING HITCH

A plow of this type may have one, two, or three plow bottoms. While the plow is working in the furrow it is carried by all three wheels and the hitch is floating; that is, the plow and the tractor are independent of one another in their up-and-down movement in passing over the slight rises and through the slight depressions of an uneven surface. When the plow is lifted for the headland, its front end rises until the hitch reaches the upper limit of its floating action. The hitch then becomes rigid, and the rear of the plow is quickly raised quite high so that it can be turned or transported on the two front wheels. The hitch floats within certain limits; beyond those limits it is rigid. The plow turns on two wheels but plows on three. Hence, the plow is called a 2-3 wheeler with semifloating hitch. The rear furrow wheel carries no lifting mechanism; no connecting or lifting rod runs to the rear wheel from the lifting mechanism in front.

The proper running of this type of plow depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), levelness (p. 41), angle of rear furrow wheel, landside pressure, heel clearance, width

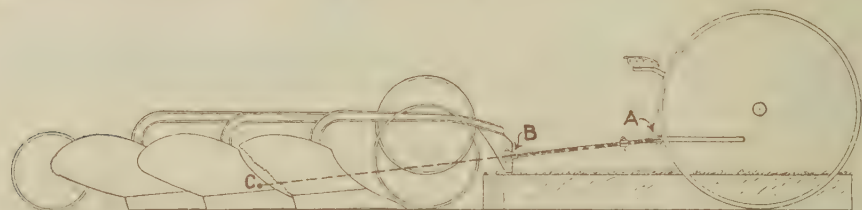


FIGURE 29.—Do not hitch too high on tractor gangs. Keep line of hitch as straight as possible.

of cut, side-draft relations, hitch, set of limits within which the hitch floats, and set and condition of jointer, colter, and special covering devices (pp. 27-33).

ANGLE OF REAR-FURROW WHEEL, LANDSIDE PRESSURE, AND HEEL CLEARANCE

The rear furrow wheel on most plows of this type is not adjustable. Hence, the angle of the rear furrow wheel, and the clearance between the heel of the rear landside and the bottom of the furrow, can not be varied. The pressure of the rear landside against the furrow wall is influenced by the side-draft relation between the tractor and the plow, and can be changed somewhat by the hitch as suggested in paragraph 5, page 43. If your plow carries an adjustable rear furrow wheel, obtain information from the manufacturer as to how the rear furrow wheel should lead, what heel clearance should exist, and what adjustments maintain these sets.

WIDTH OF CUT AND SIDE-DRAFT RELATIONS

If your plow carries two hitch bars, one of which is adjustable in length to control width of cut, adjust bars to cause front plow bottom to cut its normal width. For side-draft relations see para-

graph 5, page 44. If your plow carries the hitch shown in Figure 30, secure correct width of cut by moving the hitch to the right or left on the draw bar of the tractor or at the series of holes at W.

HITCH

If your plow carries a hitch similar in appearance and principle to the one shown in Figure 31, read paragraph 6, page 43. If your plow carries the hitch shown in Figure 30, the hitch is raised and lowered automatically as the depth of plowing is changed. This is accomplished by the bell crank and by the hitch connecting rod which runs from the bell crank to the land-wheel lever. By this arrangement, the line of hitch is supposed to be kept straight because point B is raised or lowered automatically with the depth of plowing. However, if some one has carelessly lengthened the hitch connecting rod, point B may be too low and

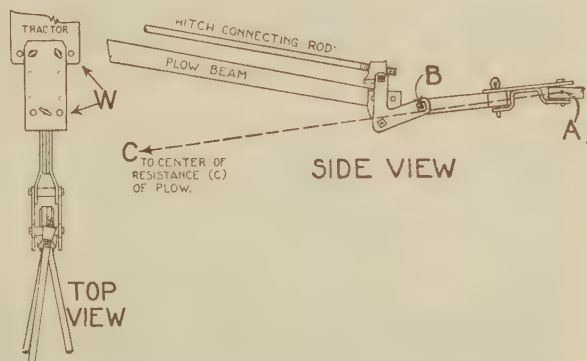


FIGURE 30

the line of hitch will be broken downward; if the connecting rod is too short, point B will be too high and the line of hitch will be broken upward. Such misadjustment may lead to serious difficulties.

If your plow carries the hitch shown in Figure 30, see paragraph 1, page 45, for hitch adjustments horizontally. For horizontal adjustment of hitch similar to Figure 31, read paragraph 5, page 43.

LIMITS WITHIN WHICH HITCH FLOATS

If your plow carries a hitch similar in appearance or principle to Figure 31, see paragraph 6, page 43 for height of hitch at point B, then adjust "limits" chain for length. The chain should be long enough to permit good, full floating action in the hitch while the plow is working, yet short enough to raise the rear of the plow sufficiently when the plow is up.

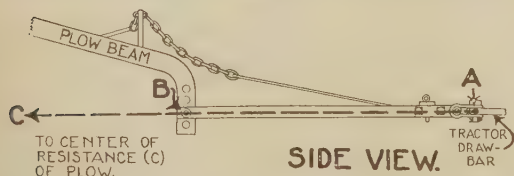


FIGURE 31

The chain must be longer for shallow plowing than for deep work. If your hitch is the one shown in Figure 30, the floating action while the plow is at work is accomplished mostly by the play between the jaws of the hitch plate and the drawbar of the tractor and between the drawbar of the tractor and the drawbar pin. If there is too much play, the rear of the plow may not be lifted high enough; such excessive play may occur because the hitch plate jaws have become spread, or through using a small drawbar pin. If excessive slop at the draw-

bar is the cause for the rear wheel not rising high enough, take out some of this play before you shorten the hitch connecting rod.

TWO-WHEELED TRACTOR PLOWS WITH SEMIFLOATING HITCH

A plow of this type usually has one or two plow bottoms. It has only two wheels—a front furrow wheel and a land wheel. While plowing, the hitch floats; that is, the plow and the tractor are somewhat independent of one another in their up-and-down movement in passing over the slight rises and through the slight depressions of an uneven surface. When the plow is lifted for the headland, the front end of the plow rises until the hitch reaches the upper limit of its floating action; then the rear of the plow is quickly raised quite high. As there is no rear furrow wheel, the heel of the



FIGURE 32.—A good job of trash covering with a 2-wheeled tractor plow

rear landside furnishes the bearing surface against the bottom of the furrow.

The proper running of this type of plow depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), levelness (p. 41), landside pressure, heel pressure, width of cut, side-draft relations, hitch, set of the limits within which the hitch floats, and set and condition of jointer, colter, and special covering devices (pp. 27-33).

LANDSIDE PRESSURE

If there seems to be too much side draft in the plow, as evidenced by furrow wall breaking when the colters are properly set, or by the rear of the plow tending to swing to the left, move the clevis on the drawbar of the tractor nearer the true line of draft of the plow; then correct width of cut as described under "Width of cut," below.

HEEL PRESSURE

Heel pressure is the pressure exerted by the heel of the rear land-side against the bottom of the furrow. Under good plowing conditions, with plow in good shape, the proper amount of heel pressure exists in this type of plow when the line of hitch in the vertical plane is straight.

Keep point B (figs. 33 and 34) as nearly as possible in an imaginary straight line from the drawbar of the tractor to the center of resistance of the plow.

If your hitch is similar to that shown in Figure 34 and you place the pin in hole P to render the hitch rigid, see paragraph 6, page 49.

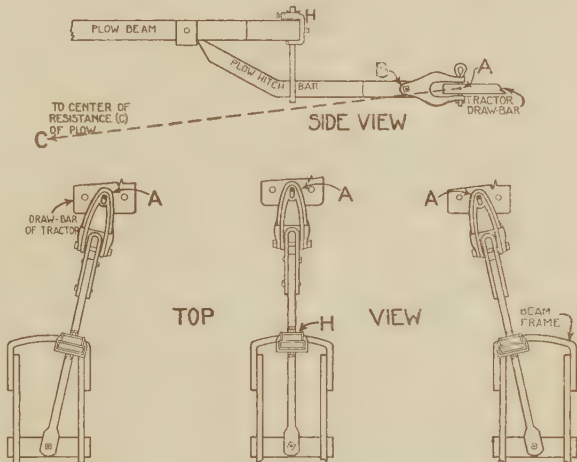


FIGURE 33

WIDTH OF CUT

If your plow carries two hitch bars, one of which is adjustable in length to control width of cut, adjust bars to cause front plow to cut its normal width.

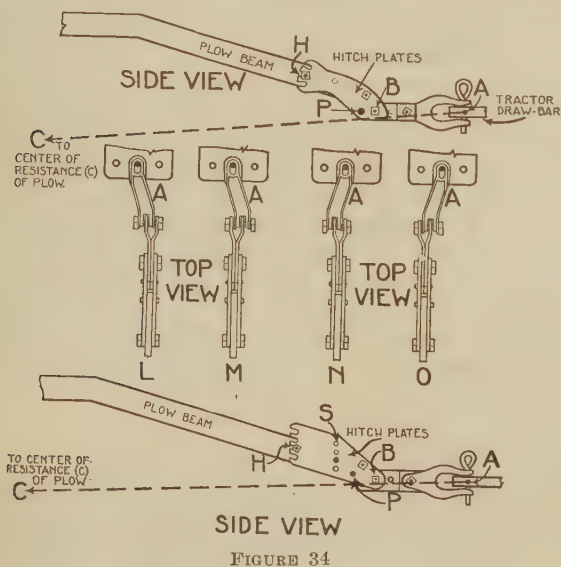


FIGURE 34

If your hitch is similar to that shown in Figure 33, width of cut is controlled by swinging the plow-hitch bar to the right or left in the frame of the plow, using adjustment H, or by shifting its front end to the right or left on the drawbar of the tractor. Choice of the adjustments will depend largely upon the side-draft relation between tractor and plow.

If your hitch is similar to that shown in Figure 34, you can obtain approximately an inch change by setting clevis A from position L to M another inch by turning the clevis over and setting it as at N, then another inch by changing from position N to O. In addition to these means on the plow, you have the holes

in the drawbar of the tractor by which to change width of cut still farther, if necessary. Some plows of the type shown in Figure 34 carry a stub beam which is reversible; one end is straight, the other end is offset, as shown in Figure 36. By reversing this stub beam the front end of the beam can be brought farther to the left or right, depending upon which side of the stub beam is up. This adjustment affects side-draft relations as well as width of cut.

SIDE DRAFT

If your plow carries two hitch bars, one of which is adjustable in length to control width of cut, see page 43. If your hitch is similar to Figure 33, and if too much side draft occurs in the plow, move clevis A nearer the true line of draft of the plow; then correct width of cut as described in second preceding paragraph. If too much side draft occurs in the tractor, move clevis A nearer the center line of pull of the tractor; then correct width of cut as described.

Whether the drawbar pin through clevis A (fig. 34) is in the center hole of the tractor drawbar, or whether it is nearly in line with the true line of draft of the plow, depends upon which side of the clevis you place upward. If you must turn the clevis over to change the side-draft relation between plow and tractor, correct width of cut as described in second preceding paragraph.

HITCH

If your plow carries two hitch bars, one of which is adjustable in length to control width of cut, keep the line of hitch straight as described in paragraph 6, page 43.

If your plow carries a hitch similar to Figure 33, raise or lower the plow hitch bar by adjustment H on the plow until point B falls as nearly as possible in an imaginary straight line from the drawbar of the tractor to the center of resistance of the plow.

If your plow carries a hitch similar to Figure 34, and the pin is removed from hole P to let the hitch float while plowing, raise or lower the hitch plate by adjustment H until point B falls as nearly as possible in an imaginary straight line from the drawbar of the tractor to the center of resistance of the plow. If you place pin P so that the hitch is robbed of floating action, see paragraph 6, page 49. The hitch plates shown in Figure 34 can be reversed to accommodate the plow at various depths of plowing to various heights of tractor drawbars.

For horizontal hitch adjustments see under "Width of cut" and "Side draft," immediately preceding.

SET OF LIMITS WITHIN WHICH HITCH FLOATS

If your hitch is similar to that shown in Figure 31, see page 45. If you raise or lower the plow hitch bar shown in Figure 33, or if you change the hitch plate in Figure 34, simply to cause the rear of the plow to rise higher, you may seriously upset heel pressure, line of hitch, and proper floating action.

TWO-WHEELED TRACTOR PLOWS WITH RIGID HITCH

A plow of this type usually is a gang of two plow bottoms. It has two wheels—no rear furrow wheel. The hitch, shown in Figure

35, is rigid at all times; that is, it has no free movement vertically except through what play exists between the drawbar of the tractor and the clevis of the plow, or between the clevis of the plow and the hitch plates on the beam. The rigid hitch makes it possible to keep the heel of the rear landside above the bottom of the furrow, the clearance under the heel, for all depths of plowing, being controlled by adjustment H in the hitch plates shown in Figure 35.

The proper running of this type depends largely upon securing and maintaining the proper down suck (p. 22), land suck (p. 22), wing fullness (p. 33), sharpness (p. 24), levelness (p. 41), landside pressure, heel clearance, width of cut (p. 47), side-draft relations (p. 48), hitch, and set and condition of jointer, colter, and special covering devices (pp. 27-33).

LANDSIDE PRESSURE

If hitch change is made to shift side draft, correct width of cut by directions in paragraph 5, page 47.

HEEL CLEARANCE

When a typical rigid hitch (fig. 35) is used the hitch plates should be set with adjustment H to allow from three-eighths to one-half of an inch clearance between the heel of the rear landside and bottom of the furrow. This clearance should exist when the plow is running. The hitch plates can be reversed to accommodate this plow to deep work. Adjustment H must be used to maintain proper heel clearance when the depth of plowing is changed. Heel clearance should be watched closely as it varies with seasons and soil conditions.

If you use a hitch similar to Figure 34 with pin in hole P to render the hitch rigid, adjust the hitch plates at H so that the heel of the rear landside rides the bottom of the furrow lightly. In the hitch illustrated at the bottom of Figure 34, the range of the adjustment at H is increased by the series of holes at S. In the hitch illustrated at the top of Figure 34, you will probably find a series of holes at the back end of the clevis itself; pin P passes through one of these holes. These means of increasing the range of adjustment H permit the operator to maintain a good line of hitch in the vertical plane whether the plow is working deep with a rather high drawbar on the tractor, or shallow with a low drawbar on the tractor.

HITCH

If your hitch is similar to that shown in Figure 35, see second preceding paragraph. If your hitch is similar to Figure 34 and you place pin in hole P to render the hitch rigid, keep point B as nearly as possible in line and yet maintain the proper heel pressure as described in preceding paragraph. For horizontal hitch adjustments see paragraph 5, page 47 and paragraph 3, page 48.

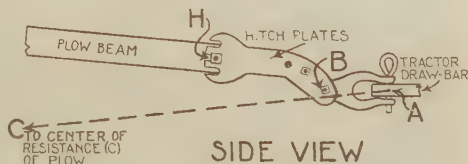


FIGURE 35

PLOWING MATCHES

Renewed interest in the art of plowing would be a powerful factor in the battle with the corn borer. There is also need of better plowing from the standpoint of soils and crops.

As an institution to revive the art of plowing and to instill decorum in field workers, the plowing match has no equal. At such matches farmers compete with one another in quality work for silver cups and other prizes. There are classes for boys, young men, and men. Competent judges score the plots by a score card, just as live-stock judges are guided by a standard of perfection.

New England might well afford again to foster community plowing matches. They can be arranged for and managed by county



FIGURE 36.—A good method of attaching covering wires to a wide base tractor sulky

agents, by colleges, by teachers of vocational agriculture, by implement dealers, by farmers' organizations, by local clubs, or by county fairs. Directions are available on how to arrange for, advertise, and manage plowing matches.

FIELD BURNERS

The only effective and successful field burners yet devised for corn-borer control work are the large, expensive burners used by the control forces as emergency equipment where large areas must be burned quickly. It would not be practical for a farmer or group of farmers to attempt to use such equipment, and no small machines have yet succeeded in passing the necessary requirements.

